FINAL

CARBON MONOXIDE AND PARTICULATE MATTER AIR QUALITY MODELING

PARTICULATE MATTER PREVENTION OF SIGNIFICANT DETERIORATION INCREMENT ANALYSIS

WINTER SEASON MOBILE EMISSIONS ESTIMATES OF CRITERIA AND TOXIC POLLUTANTS

VISIBILITY MODELING

WINTER USE PLAN/SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

YELLOWSTONE NATIONAL PARK
GRAND TETON NATIONAL PARK
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ABBREVIATIONS AND ACRONYMS

AAQS	Ambient Air Quality Standard
Alt	Alternative
AMDU	Average mean daily use
bkgd	Background
BSFC	Brake Specific Fuel Consumption
CFR	Code of Federal Regulations
CO	Carbon Monoxide
DSEIS	Draft Supplemental Environmental Impact Statement
EM	Emission Factor
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
FEIS	Final Environmental Impact Statement
FSEIS	Final Supplemental Environmental Impact Statement
g	Gram
GRTE	Grand Teton National Park
GYA	Greater Yellowstone Area
HC	Hydrocarbons
HDT	Heavy-Duty Truck
hp	Horsepower
IMPROVE	Interagency Monitoring of Protected Visual Environments
ISCST	Industrial Source Complex Short Term Model
LDGT	Light-Duty Gasoline Truck
MDEQ	Montana Department of Environmental Quality
mph	Miles-per-hour
NAAQS	National Ambient Air Quality Standard
NO_X	Nitrogen Oxides
NPS	National Park Service
PHTV	Peak hourly traffic volume
PM_{10}	Particulate Matter (less than 10 microns in diameter)
ppm	Parts per million
PSD	Prevention of Significant Deterioration

ABBREVIATIONS AND ACRONYMS (CONTINUED)

SC	Snowcoach
SEIS	Supplemental Environmental Impact Statement
SM	Snowmobile
SWRI	Southwest Research Institute
YELL	Yellowstone National Park
tpy	Tons per year

1. INTRODUCTION

In order to assess the relative impacts of the proposed winter use alternatives on ambient air quality in the Greater Yellowstone Area (GYA), short-term air quality analyses were performed by means of atmospheric dispersion modeling for carbon monoxide (CO) and particulate matter (PM_{10}). A screening level PM_{10} Prevention of Significant Deterioration (PSD) increment analysis and a visibility modeling also were performed for the full implementation year of each scenario. In addition, the total winter-season mobile emissions of CO, PM_{10}, nitrogen oxides (NO_X), hydrocarbons (HC), and selected toxic air pollutants inside the park units were calculated for the full implementation year of each scenario. These analyses were performed in support of the Winter Use Plans/Supplemental Environmental Impact Statement (SEIS) for Yellowstone (YELL) and Grand Teton (GRTE) National Parks and the John D. Rockefeller, Jr., Memorial Parkway.

2. SEIS ALTERNATIVES

2.1. Alternatives 1a and 1b

Alternatives 1a and 1b are the same except that Alternative 1b defers implementation for one more year. Under Alternative 1a, only snowcoaches would travel in the three park units beginning in the 2003-2004 winter season. This Alternative is similar to the Preferred Alternative presented in the Winter Use Plans, Final Environmental Impact Statement (FEIS) (NPS, 2000c) and the Alternative selected in the November 2000 Record of Decision as modified by the final rule published in the *Federal Register* on January 22, 2001. The full implementation season of Alternative 1a is Year 2 (2003-2004 winter season). For Alternative 1b, Year 1 (2002-2003 winter season) is characterized by the existing use, Year 2 is characterized by a 50 percent reduction in snowmobile entries at the West and South Yellowstone Entrance Stations, and Year 3 (2004-2005 winter season) is the full implementation season.

2.2. Alternative 2

Alternative 2 contains several scenarios to accommodate the phase-in schedule for different vehicle types. For rental and outfitter snowmobiles (70 percent of existing snowmobile fleet use), from Year 1 (2002-2003 winter season) forward, only 4-stroke engine snowmobiles and other models whose engine family meets an emission standard of 149 g/hp-hr for CO and 56 g/hp-hr for HC would be allowed in the park units. This represents the proposed 2010 U.S. Environmental Protection Agency (EPA) emission rule for snowmobiles and constitutes a 50 percent reduction over current snowmobile emissions (Federal Register, 2001). The proposed rule also notes that "limits on HC emissions will serve to simultaneously limit PM_{10}."

For public snowmobiles (30 percent of the snowmobile fleet) for Years 1 and 2 (2002-2003 and 2003-2004 winter seasons), only 4-stroke snowmobiles and two-stroke engine models using bio-base fuels and lubricants (10 percent ethanol blend fuel and full synthetic low-emission oil) would be allowed in the park units. For Year 3 (2004-2005 winter season) and beyond, only 4-stroke snowmobiles and other models whose engine family meets an emission standard of 149 g/hp-hr for CO and 56 g/hp-hr for HC (proposed 2010 EPA emission rule for snowmobiles) would be allowed in the park units. The implementation date of Alternative 2 is Year 3 (2004 –

2005 winter season), and Years 1 and 2 (2002 – 2003 and 2003 – 2004 winter seasons) are characterized by the existing use, except for snowmobile use.

2.3. Alternative 3

Under Alternative 3, new cleaner and quieter snowmachine technologies would be required for all recreational oversnow vehicles entering the parks. The National Park Service (NPS) would implement this requirement through the issuance of outfitter and guide permits. Interim or initial emission and sound requirements would be based on best available technology and evaluated annually under an adaptive management framework. The yearly evaluation would result in an adjustment of snowmobile use limits if necessary for protection of air quality, wildlife, visitor experience, and natural soundscapes as defined by NPS policy and determined by monitoring. The full implementation date of Alternative 3 is Year 2 (2003 – 2004 winter season), and Year 1 (2002–2003 winter season) is characterized by the existing use.

2.4. Alternative 4

Alternative 4 is similar to Alternative 3 except for the snowmobile usage. The full implementation date of Alternative 4 is Year 2 (2003 – 2004 winter season), and Year 1 (2002–2003 winter season) is characterized by the existing use.

3. CO AND PM_{10} AIR QUALITY MODELING

3.1. Modeling Locations

Figure 1 notes the general park areas, and Figure 2 notes some of the areas of interest in YELL. Six locations noted in Table 1 were selected for the air quality modeling analyses based on their characteristics and vehicle mix by alternative.

The West Yellowstone Entrance is characterized by two fee collection booths where snowmobiles and snowcoaches idle when passing through. This creates stop-and-go, delay, and queuing traffic conditions. Also, an express lane exists at a third booth in which traffic is designed to be free flowing.

The West Yellowstone Entrance to Madison Junction road segment is approximately 14 km long, and the segment selected for modeling is a 6-km stretch of road starting approximately 5 km from the West Yellowstone Entrance. The modeled segment was subdivided into four short links due to directional changes in the roadway.

The Flagg Ranch staging area to Colter Bay village road segment is approximately 16 km long, and the segment selected for modeling is a 10-km stretch of the road starting approximately 5 km from Flagg Ranch. This road segment is characterized by an elevated groomed motorized trail for snowmobiles adjacent to a plowed highway. Therefore, it was subdivided into eight short links (four for the main road and four for the adjacent trail).

The Mammoth Hot Springs to Tower Roosevelt road segment is approximately 47 km long, and the segment selected for modeling is a 6-km stretch of the road starting approximately 10 km from Mammoth Hot Springs. This road segment is part of I-89 and is characterized by wheeled vehicle use only. It was also subdivided into four short links. It was assumed that the vehicle use does not change yearly or by alternative and that the mission factors do not change either.

The Old Faithful staging area contains three main parking areas designed primarily for visitors, while the Flagg Ranch staging contains two main parking areas designed for visitors, guides, and outfitters. Traffic in both staging areas is in idling or slow-moving mode for long periods of time. Therefore, they were modeled as area sources. In each of the two staging areas, a single area encompassing the major parking lots were drawn and used as modeling areas.

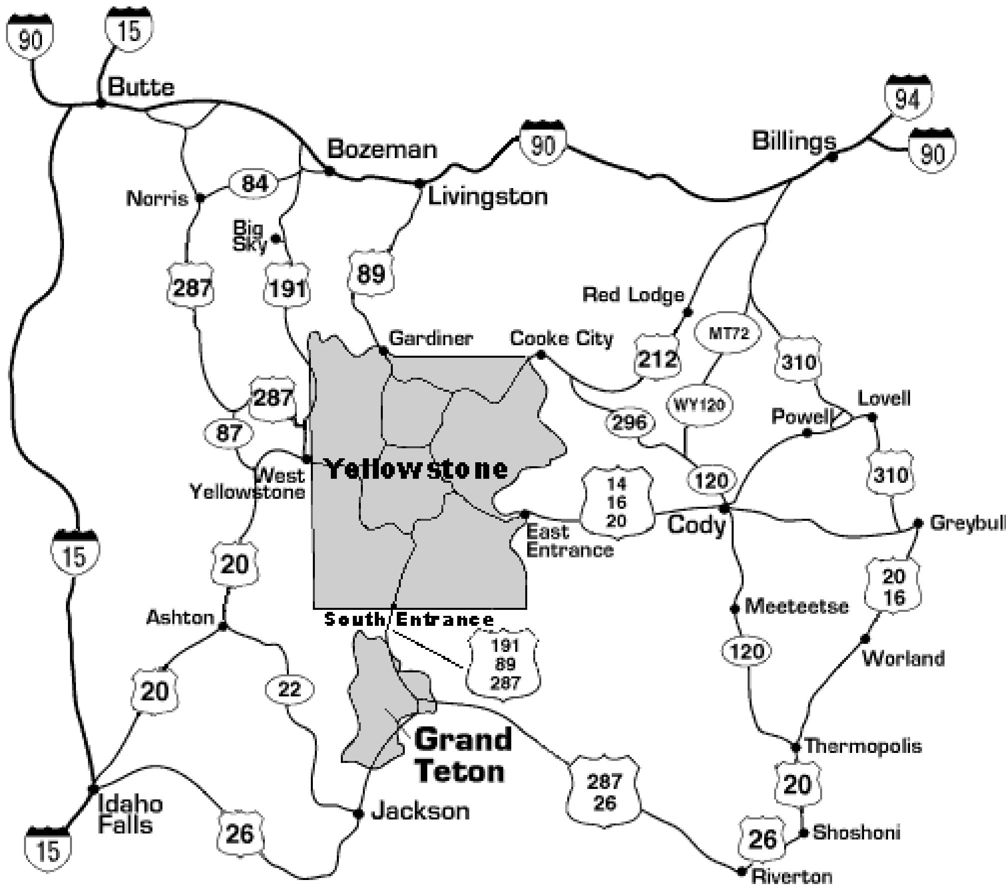

Figure 1. Greater Yellowstone Area

Figure 2. Yellowstone National Park

Table 1. Selected Locations for Modeling Application and Vehicle Mix by Alternative

Location	Type	Vehicle Mix for the Full Implementation Year			
		Alternatives 1a and 1b	Alternative 2	Alternative 3	Alternative 4
West Yellowstone Entrance	Fee Collection Booths	Snowcoach travel only	Snowcoach and snowmobile travel only	Snowcoach and snowmobile travel only	Snowcoach and snowmobile travel only
Old Faithful	Staging Area	Snowcoach travel only	Snowcoach and snowmobile travel only	Snowcoach and snowmobile travel only	Snowcoach and snowmobile travel only
Flagg Ranch	Staging Area	Snowcoach travel only	Snowcoach and snowmobile travel only	Snowcoach and snowmobile travel only	Snowcoach and snowmobile travel only
Mammoth to Northeast Entrance	Plowed Highway	Wheeled vehicle travel only	Wheeled vehicle travel only	Wheeled vehicle travel only	Wheeled vehicle travel only
West Entrance to Madison	Groomed Motorized Route	Snowcoach travel only	Snowcoach and snowmobile travel only	Snowcoach and snowmobile travel only	Snowcoach and snowmobile travel only
Flagg Ranch to Colter Bay	Groomed Motorized Trail/Plowed Road	Snowcoach travel only	Snowmobile travel only		Snowmobile travel only

3.2. Modeling Procedures

As noted in the modeling protocol (EA, 2001), for each alternative, the worst-case maximum ambient concentrations of CO and PM_{10} were estimated using EPA-approved air quality models for four pre-defined vehicle fleets operating in six locations.

For the West Yellowstone Entrance Station and the roadway links, the EPA model CAL3QHC (EPA, 1995a) was used to predict the worst-case maximum 1-hr average concentrations of CO and PM_{10}. CAL3QHC predicts 1-hour average concentrations of inert pollutants from both moving and idling motor vehicles at roadway intersections. It includes the line source dispersion model CALINE3 (Benson, 1979) and a traffic algorithm for estimating vehicular queue lengths at signalized intersections. Even though the West Yellowstone Entrance is not a signalized intersection, it presents the characteristics of one (delay approach, idle, and acceleration). Furthermore, persistence factors of 0.7 for the 8-hr averaging period and 0.4 for the 24-hr averaging period (EPA, 1992) were applied to the maximum 1-hr average concentrations to calculate the maximum 8-hr average CO concentrations and 24-hr average PM_{10} concentrations.

For the staging areas, the EPA model ISCST3 (EPA, 1995b) was used to predict the maximum 1-hr and 8-hr average CO concentrations and maximum 24-hr average PM_{10} concentrations. ISCST3 is a refined dispersion model based on the steady-state Gaussian plume equation designed to estimate concentration or deposition levels for each source-receptor combination.

For the West Yellowstone Entrance, a referential system with origin at the second fee collection booth was used to allocate the end points of the links and the receptor locations. Nine links representing the approach, queue, and departure links of each of the three lanes were defined. The end point coordinates of the links extend up to 1,000 ft for each link. Ten receptors were located outside the mixing zone, 200 feet apart along the northern and southern side of the entrance. For the roadway links, receptors were located on both sides of the road segment links outside the mixing zone. For the staging areas, a gridded receptor system was located in the vicinities of the areas using a 100-meter spacing up to a distance of 1,000 m.

The predicted maximum concentrations of CO and PM_{10} imparted to traffic conditions of the proposed alternatives were then compared to those of the existing conditions in order to determine the amount and direction of changes in maximum CO and PM_{10} concentrations. The contribution of each vehicle type to the generation of CO and PM_{10} also was assessed for each scenario.

3.3. Emission Factors

A composite running emission factor in grams per vehicle-mile for each free flow link and an idle emission factor in grams per vehicle-hour for each queue link and for the staging areas were required. The emission factors were developed as outlined in Appendix A (EA 2002).

3.3.1. 2-Stroke Snowmobile

2-stroke snowmobile emission factors, expressed in g/hp-hr, were available from 14 different engine dynamometer emission tests (see Appendix A). For the dispersion modeling and emission inventory preparation, emission factors expressed in terms of g/mile were required. Since all the 2-stroke snowmobile emission tests were performed over an engine dynamometer drive cycle, emission factors in terms of g/mile were not available. Therefore, a conversion from g/hp-hr to g/mile was necessary. The g/mile conversion factors was calculated from the intermediate modes (designed to represent field operating conditions) of all the available test data using the methodology used by EPA to convert emission factors of heavy-duty vehicles (HDV). This methodology is based on the following relationship (EPA, 2002b):

$$Conversion\ Factor\ (hp-hr/mile) = \left[\frac{Fuel\ Density\ (lb/gal)}{BSFC\ (lbs/hp-hr)\ x\ Fuel\ Economy\ (miles/gal)}\right]$$

Since both HDV and snowmobiles are tested over engine dynamometer drive cycles, this methodology may be used to convert snowmobile emission factors. The BSFC and fuel density were readily available from the emission test data; however, the fuel economy information was not. Therefore, data from snowmobile manufacturers and owner information were used to estimate these data. In the conversion process, mode 4 of the engine dynamometer drive cycle was used for low speeds (i.e., 15 mph), and mode 3 was used for average roadway operating speeds (i.e., 35 mph). Fuel economies of 11 and 8 miles/gal were assumed for mode 4 and 3, respectively. An average fuel density of 6.2 lb/gal also was assumed. The calculated conversion factors from the average emission factor from all the available tests were 0.69 and 0.36 hp-hr/mile for the 35 mph and 15 mph modes, respectively.

Table 2 presents the 2-stroke snowmobile traveling emission factors, both in g/hp-hr and g/mile, used in the air quality analysis. The idle emission factors are presented in Table 3. They represent the average of all the mode 5 (idle mode) unweighted emission rates in g/hr from the same aforementioned tests. The emission factors at 15 mph (minimum speed measured) were used at the West Yellowstone Entrance, and the emission factor at 35 mph were used for other roadway segments. At the staging area, the idle emission factors were used.

3.3.2. 4-Stroke Snowmobile

In February 2002, Southwest Research Institute (SWRI) measured emission factors of the Arctic Cat® 4-stroke Touring production model over a modified (vehicle speed) 5-mode chassis dynamometer using a reported in-field vehicle speed and engine speed correlation (SWRI, 2002). The measured emission factors are presented in Appendix A along with the speed correlations. Since this first-of-the-kind test correlates vehicle speed and emissions factors, expressed in g/mile and no conversion is needed, the emission factors at 15 mph and 35 mph from this test were used in the present air quality modeling and are presented in Table 2. The emission factors at 15 mph (minimum speed measured) were used at the West Yellowstone Entrance, and the emission factors at 35 mph were used for other roadway segments. At the staging area, the idle emission factors were used. The idle emission factors were the mode 5 unweighted emission rates in g/hr of the same test. They are presented in Table 3.

3.3.3. Snowcoach

In previous air quality work in support of the earlier Draft EIS, the emission factors of light duty gasoline trucks (LDGT) were used to represent snowcoach emission factors since no snowcoach emission data existed at that time, and the majority of snowcoaches operating in Yellowstone NP are assumed to be converted passenger vans. To date, the only snowcoach emission test available was performed by SWRI (SWRI, 2001). In that project, a passenger van (2000 Ford E-

350 Clubwagon XLT equipped with a Triton EFI V-10 gasoline engine) was tested on a chassis dynamometer using developed conditions (test cycle) as an approximate snowcoach operation to determine an estimated emissions range over the course of a snowcoach trip. The results of the test were presented in term of closed loop and open loop conditions (see Appendix A).

This SWRI study represents the only snowcoach test. Therefore, the data were used in the air quality support of the SEIS with some modifications. Since the fraction of time that a snowcoach operates in closed or open loop is unknown, it was assumed that snowcoaches operate one-third of the time in closed loop and two-thirds of the time in open loop at maximum load given the operating conditions of snowcoaches in the field. Thus, the snowcoach traveling emission factors were the time-weighted average of these two modes for HC, CO, and NO_X, which are also highlighted in Table 2. The test data do not contain PM_{10} emission factors and idle emission factors that are required in the dispersion modeling and emission inventory analyses. Therefore, for PM_{10}, the EPA Mobile6.2 model traveling emission factors for pre-1970 LDGT at 13.7 mph, the average snowcoach speed used in the SWRI test, were used. Finally, the idle emission factors were obtained from the EPA's idling vehicle emissions publication (EPA, 1998). The snowcoach PM_{10} idle emission factors also are presented in Table 3.

3.3.4. Wheeled Vehicles

The wheeled vehicle emission factors were obtained from the execution of Mobile6.2 (EPA, 2002) and are summarized in Table 4.

3.4. Traffic Characteristics

Traffic counts from a February 2000 West Yellowstone Entrance monitoring project (NPS 2000b) indicated that the period between 9 A.M. and 10 A.M. represented the peak traffic hour and that on average 309 snowmobiles entered the park at that location during that time period. The average total daily entrance was 923 snowmobiles. This implies that approximately 33.5 percent of the snowmobiles entered the park during the peak hour. The winter motorized use scenarios (Appendix B) indicate that the ratio of the average mean daily use (AMDU) to the average peak day use of snowmobiles is 0.57 for the existing conditions. Assuming that these percentages hold true for each alternative, vehicle type, and location, the peak hourly traffic volume (PHTV) may be calculated as PHTV = AMDU*0.33/0.57, where AMDU is the average mean daily use. For the West Yellowstone Entrance, PHTV would be multiplied by the lane ratios (vehicles per lane/peak vehicle number). From the monitoring project data, these ratios are 0.22, 0.16, and 0.62 for lane 1, lane 2, and lane 3, respectively. The peak hourly traffic volumes for each vehicle type and for each alternative are presented in Appendix C.

Videotapes recorded during the monitoring project indicated that the average idle time length is about 30 seconds and that the average approach speed is about 15 mph for the West Yellowstone Entrance. Even though the third lane was designed to be free flowing, it was observed that on average motorists idle for a very short time of about 5 seconds. However, for Alternative 1, it was assumed that no express lane exists and that all lanes have the same idle time of 30 seconds. The average vehicle speed was 35 mph on the parks' roadways. Communication with the YELL/GTRE planning staff and rangers revealed that snowmobiles typically idle for 5 minutes on average in both the Old Faithful and Flagg Ranch staging areas.

Table 2. Snowmobile and Snowcoach Traveling Emission Factors

Alt	Year	User	Composite Emission Factor (g/hp-hr)				Composite Emission Factor (g/mile) @ 15 mph				Composite Emission Factor (g/mile) @ 35 mph			
			HC	NO_X	CO	PM_{10}	HC	NO_X	CO	PM_{10}	HC	NO_X	CO	PM_{10}
Snowmobile														
1a	2002-2003	All	127.33[3]	0.75[3]	341.51[3]	1.85[3]	44.86	0.26	120.32	0.65	85.92	0.51	230.44	1.25
	2003-2004	All	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1b	2002-2003	All	127.33[3]	0.75[3]	341.51[3]	1.85[3]	44.86	0.26	120.32	0.65	85.92	0.51	230.44	1.25
	2003-2004	All	127.33[3]	0.75[3]	341.51[3]	1.85[3]	44.86	0.26	120.32	0.65	85.92	0.51	230.44	1.25
	2004-2005	All	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	2002-2003	RO	56[1]	NC	149[1]	1.35[1]	20.34	0.16	54.13	0.49	38.49	0.30	102.42	0.93
		GP	127.33[3]	0.75[3]	341.51[3]	1.85[3]	44.86	0.26	120.32	0.65	85.92	0.51	230.44	1.25
	2003-2004	RO	56[1]	NC	149[1]	1.35[2]	20.34	2.42[4]	54.13	0.49	38.49	4.93[4]	102.42	0.93
		GP	127.33[3]	0.75[3]	341.51[3]	1.85[3]	44.86	0.26	120.32	0.65	85.92	0.51	230.44	1.25
	2004-2005	All	56[1]	NC	149[1]	1.35[1]	20.34	0.16	54.13	0.49	38.49	0.30	102.42	0.93
3	2002-2003	All	127.33[3]	0.75[3]	341.51[3]	1.85[3]	44.86	0.26	120.32	0.65	85.92	0.51	230.44	1.25
	2003-2004	All	NC	NC	NC	NC	3.28[4]	2.42[4]	138.90[4]	0.05[4]	2.28[4]	4.93[4]	36.50[4]	0.03[4]
4	2002-2003	All	127.33[3]	0.75[3]	341.51[3]	1.85[3]	44.86	0.26	120.32	0.65	85.92	0.51	230.44	1.25
	2003-2004	All	NC	NC	NC	NC	3.28[4]	2.42[4]	138.90[4]	0.05[4]	2.28[4]	4.93[4]	36.50[4]	0.03[4]
Snowcoach														
All	All	All	NC	NC	NC	NC	1.106[5]	1.394[5]	66.720[5]	0.279[6]				

[1] EPA 2010 snowmobile emission factor proposal.
[2] 50 percent of EPA Nonroad 2-stroke snowmobile emission factor.
[3] Average of available 2-stroke snowmobile emission tests.
[4] SWRI-measured Arctic Cat® 4-stroke Touring Production model prototype snowmobile emission factor.
[5] SWRI-measured snowcoach emission factor at 13.7 mph.
[6] Mobile6.2 Pre-1970 LDGT PM_{10} emission factor at 13.7 mph.
NA = No snowmobile in the scenario.
NC = No conversion needed.

Table 3. Snowmobile and Snowcoach Idle Emission Factors

Alternative	Year	User	Idle Emission Factor (g/hr)			
			HC	NO_X	CO	PM_{10}
Snowmobile						
1a	2002-2003	All	569.59[2]	1.37[2]	320.47[2]	2.81[2]
	2003-2004	All	NA	NA	NA	NA
1b	2002-2003	All	569.59[2]	1.37[2]	320.47[2]	2.81[2]
	2003-2004	All	569.59[2]	1.37[2]	320.47[2]	2.81[2]
	2004-2005	All	NA	NA	NA	NA
2	2002-2003	Rentals and Outfitters	298.98[1]	0.50[3]	171.16[1]	1.65[1]
		General Public	569.59[2]	1.37[2]	320.47[2]	2.81[2]
	2003-2004	Rentals and Outfitters	298.98[1]	0.50[3]	171.16[1]	1.65[1]
		General Public	569.59[2]	1.37[2]	320.47[2]	2.81[2]
	2004-2005	All	298.98[1]	0.50[3]	171.16[1]	1.65[1]
3	2002-2003	All	569.59[2]	1.37[2]	320.47[2]	2.81[2]
	2003-2004	All	12.05[3]	0.50[3]	111.20[3]	0.37[3]
4	2002-2003	All	569.59[2]	1.37[2]	320.47[2]	2.81[2]
	2003-2004	All	12.05[3]	0.50[3]	111.20[3]	0.37[3]
Snowcoach						
All	All	All	30.7[4]	487[4]	7.47[4]	NA

[1] 50 percent decrease of the existing 2-stroke level (as stipulated by the EPA proposal).
[2] Average of all the mode 5 of all the available 2-stroke snowmobile tests.
3..Average SWRI-measured Arctic Cat® 4-stroke Touring Production model mode 5 emission rates.
4..From idling vehicle emissions. EPA420-F-98-014.
NA = Non available.

Table 4. Wheeled Vehicle Emission Factors[1]

Vehicle Type	CO	PM_{10}	HC	NO_X
	Traveling @ 35 mph (g/mile)			
Automobile	19.990	0.028	0.874	0.887
Light Truck	26.930	0.030	1.258	1.287
Heavy Truck	4.147	0.290	0.852	13.588
Tour Bus	7.363	0.420	0.669	15.950
Shuttle Van	24.080	0.030	1.063	1.474
	Idle (g/hr)			
Automobile	350.520	NA	21.490	3.410
Light Truck	471.170	NA	30.220	4.590
Heavy Truck	142.260	1.103	26.140	37.900
Tour Bus	142.260	1.103	26.140	37.900
Shuttle Van	471.170	NA	30.220	4.590

1..All Alternatives
NA = Non applicable.

3.5. Meteorology, Terrain and Air Quality

For the CAL3QHC modeling, meteorological conditions included low wind speed of 1.0 meter/second, stable atmosphere (class 6), and low mixing height of 50 meters. The latter was derived from the average morning mixing height data for the Jackson Hole Airport for the months of January and February 2000 (National Climatic Data Center data). The hourly surface and upper air meteorological data required by ISCT3 were processed from the Jackson Hole Airport data for the 1999 - 2000 winter months. A surface roughness of 283 cm representing a fir forest was selected. Furthermore, for PM_{10} modeling, a settling velocity and deposition velocity of 0.5 cm/s were selected (Zanneti, 1990). Throughout the modeling exercises, an average terrain elevation of 500 feet was used.

The ambient background concentrations of CO and PM_{10} were estimated following the guidelines of 40 CFR 51, Appendix W. For the West Entrance, the available monitoring data collected from January 12 to March 28, 1995 in the town of West Yellowstone (NPS, 1996) were used. The background concentrations were estimated to be 3.0 ppm for the 1-hr average CO and 23.0 $\mu g/m^3$ for the 24-hr PM_{10}. The calculated 8-hr average CO background concentration is 2.10 ppm. For locations inside the park, the 24-hr average PM_{10} background concentration was integrated from the Interagency Monitoring of Protected Visual Environments (IMPROVE) network aerosol data and were estimated to be 5.0 $\mu g/m^3$. However, since there were no CO monitors inside the parks at the time of the study, the ratio of the PM_{10} background concentrations at the West Entrance and inside the park was conservatively applied to the West Entrance CO background concentration to determine the inside-the-park CO background concentration. This yielded 1-hr average and 8-hr average CO background concentrations of 0.65 ppm and 0.46 ppm, respectively, inside the park.

3.6. Air Quality Modeling Results for the West Yellowstone Entrance

3.6.1. CO Concentrations

Tables 5 to 7 present the CO modeling results for the West Yellowstone Entrance. Table 5 shows the predicted maximum 1-hr average CO concentrations, and Table 6 shows the calculated maximum 8-hr average CO concentrations. The percentages of the predicted maximum CO concentrations (i.e., without the background concentration) to the predicted maximum CO concentrations for the existing conditions also are provided. The percent contributions of each vehicle type, including snowplows (heavy-duty trucks or HDT), to the generation of CO are presented in Table 7.

Table 5. Maximum 1-hour Average CO Concentrations at the West Entrance

Alternative	1-hr Maximum Concentration (w/o bkgd) (ppm)	1-hr Maximum Concentration (w/ bkgd) (ppm)	Percent Relative to Existing Conditions (w/o bkgd)
Existing Conditions (2001-2002)	9.20	12.20	100.00
Alt 1a Year 1 (2002-2003)	2.90	5.90	31.52
Alt 1a Year 2 (2003-2004) and beyond	1.20	4.20	13.04
Alt 1b Year 1 (2002-2003)	9.20	12.20	100.00
Alt 1b Year 2 (2003-3004)	2.90	5.90	31.52
Alt 1b Year 3 (2004-2005) and beyond	1.20	4.20	13.04
Alt 2 Year 1 (2002-2003)	6.60	9.60	71.74
Alt 2 Year 2 (2003-3004)	6.90	9.90	75.00
Alt 2 Year 3 (2004-2005) and beyond	5.70	8.70	61.96
Alt 3 Year 1 (2002-2003)	9.20	12.20	100.00
Alt 3 Year 2 (2003-3004) and beyond	4.60	7.60	50.00
Alt 4 Year 1 (2002-2003)	9.20	12.20	100.00
Alt 4 Year 2 (2003-3004) and beyond	6.00	9.00	65.22

Notes: A percent equal to 100 means equal concentrations.
A percent less than 100 means a decrease in concentration.
A percent greater than 100 means an increase in concentration.

Table 6. Maximum 8-hour Average CO Concentrations at the West Entrance

Alternative	8-hr Maximum Concentration (w/o bkgd) (ppm)	8-hr Maximum Concentration (w/ bkgd) (ppm)	Percent Relative to Existing Conditions (w/o bkgd)
Existing Conditions (2001-2002)	6.44	8.54	100.00
Alt 1a Year 1 (2002-2003)	2.03	4.13	31.52
Alt 1a Year 2 (2003-2004) and beyond	0.84	2.94	13.04
Alt 1b Year 1 (2002-2003)	6.44	8.54	100.00
Alt 1b Year 2 (2003-3004)	2.03	4.13	31.52
Alt 1b Year 3 (2004-2005) and beyond	0.84	2.94	13.04
Alt 2 Year 1 (2002-2003)	4.62	6.72	71.74
Alt 2 Year 2 (2003-3004)	4.83	6.93	75.00
Alt 2 Year 3 (2004-2005) and beyond	3.99	6.09	61.96
Alt 3 Year 1 (2002-2003)	6.44	8.54	100.00
Alt 3 Year 2 (2003-3004) and beyond	3.22	5.32	50.00
Alt 4 Year 1 (2002-2003)	6.44	8.54	100.00
Alt 4 Year 2 (2003-3004) and beyond	4.20	6.30	65.22

Notes: A percent equal to 100 means equal concentrations.
A percent less than 100 means a decrease in concentration.
A percent greater than 100 means an increase in concentration.

Table 7. Contributions to CO Concentrations at the West Entrance

Alternative	Contribution (percent)						
	SM	**SC**	**Auto**	**LDT**	**HDT**	**Bus**	**Van**
Existing Conditions (2001-2002)	98.09	1.66	0.00	0.00	0.25	0.00	0.00
Alt 1a Year 1 (2002-2003)	96.27	3.25	0.00	0.00	0.48	0.00	0.00
Alt 1a Year 2 (2003-2004) and beyond	0.00	98.61	0.00	0.00	1.39	0.00	0.00
Alt 1b Year 1 (2002-2003)	98.09	1.66	0.00	0.00	0.25	0.00	0.00
Alt 1b Year 2 (2003-3004)	96.27	3.25	0.00	0.00	0.48	0.00	0.00
Alt 1b Year 3 (2004-2005) and beyond	0.00	98.61	0.00	0.00	1.39	0.00	0.00
Alt 2 Year 1 (2002-2003)	97.29	2.36	0.00	0.00	0.35	0.00	0.00
Alt 2 Year 2 (2003-3004)	97.39	2.28	0.00	0.00	0.34	0.00	0.00
Alt 2 Year 3 (2004-2005) and beyond	96.53	3.06	0.00	0.00	0.41	0.00	0.00
Alt 3 Year 1 (2002-2003)	98.09	1.66	0.00	0.00	0.25	0.00	0.00
Alt 3 Year 2 (2003-3004) and beyond	82.77	16.52	0.00	0.00	0.71	0.00	0.00
Alt 4 Year 1 (2002-2003)	98.09	1.66	0.00	0.00	0.25	0.00	0.00
Alt 4 Year 2 (2003-3004) and beyond	96.34	3.10	0.00	0.00	0.56	0.00	0.00

None of the predicted 1-hr average CO concentrations (with the background concentration) exceed the Montana Ambient Air Quality Standards (AAQS) for CO of 23 ppm, and none exceed the Wyoming or National AAQS, which is 35 ppm. Similarly, none of the calculated 8-hr average CO concentrations (with the background concentration) exceed the National, Wyoming, and Montana AAQS for CO, which is 9 ppm. Note that the maximum 8-hr average CO concentration for the existing conditions (8.54 ppm) compares favorably with the monitored highest CO concentration (8.90 ppm) recorded during the 1998 to 2001 State of Montana CO monitoring in West Yellowstone (MDEQ, 2002).

All the maximum 1-hr average and 8-hr average CO concentrations for the full implementation years of Alternatives 2, 3, and 4 are higher than those of the full implementation years of Alternatives 1a and 1b. Moreover, all the maximum 1-hr average and 8-hr average CO concentrations for the interim and full implementation years of Alternatives 1a, 1b, 2, 3, and 4 are lower than those of the existing conditions. Furthermore, the impacts of the full implementation years of Alternatives 1a and 1b show the highest decrease relative to the existing conditions, followed by Alternatives 3, 2, and 4.

For all the scenarios, snowmobile contributions to the generation of CO are the highest except in Alternatives 1a and 1b in which there is no snowmobile use and only snowcoaches travel in the park units.

3.6.2. PM_{10} Concentrations

Tables 8 presents the PM_{10} modeling results for the West Yellowstone Entrance. It shows the predicted maximum 1-hr average PM_{10} concentrations and the calculated maximum 24-hr average PM_{10} concentrations. The percentages of the predicted maximum PM_{10} concentrations (i.e., without the background concentration) to the predicted maximum PM_{10} concentration for the existing conditions also are provided. The percent contributions of each vehicle type, including snowplows (HDT), to the generation of PM_{10} are presented in Table 9.

Table 8. Maximum PM_{10} Concentrations at the West Entrance

Alternative	1-hr Maximum Concentration (w/o bkgd) ($\mu g/m^3$)	24-hr Maximum Concentration (w/o bkgd) ($\mu g/m^3$)	24-hr Maximum Concentration (w/ bkgd) ($\mu g/m^3$)	Percent Relative to 24-hr Maximum Existing Conditions (w/o bkgd)
Existing Conditions (2001-2002)	78.00	31.20	54.20	100.00
Alt 1a Year 1 (2002-2003)	24.00	9.60	32.60	30.77
Alt 1a Year 2 (2003-2004) and beyond	1.00	0.40	23.40	1.28
Alt 1b Year 1 (2002-2003)	78.00	31.20	54.20	100.00
Alt 1b Year 2 (2003-3004)	24.00	9.60	32.60	30.77
Alt 1b Year 3 (2004-2005) and beyond	1.00	0.40	23.40	1.28
Alt 2 Year 1 (2002-2003)	60.00	24.00	47.00	76.92
Alt 2 Year 2 (2003-3004)	63.00	25.20	48.20	80.77
Alt 2 Year 3 (2004-2005) and beyond	56.00	22.40	45.40	71.79
Alt 3 Year 1 (2002-2003)	78.00	31.20	54.20	100.00
Alt 3 Year 2 (2003-3004) and beyond	6.00	2.40	25.40	7.69
Alt 4 Year 1 (2002-2003)	78.00	31.20	54.20	100.00
Alt 4 Year 2 (2003-3004) and beyond	11.00	4.40	27.40	14.10

Notes: A percent equal to 100 means equal concentrations.
A percent less than 100 means a decrease in concentration.
A percent greater than 100 means an increase in concentration.

Table 9. Contributions to PM_{10} Concentrations at the West Entrance

Alternative	Contribution (percent)						
	SM	SC	Auto	LDT	HDT	Bus	Van
Existing Conditions (2001-2002)	99.27	0.35	0.00	0.00	0.38	0.00	0.00
Alt 1a Year 1 (2002-2003)	98.55	0.69	0.00	0.00	0.76	0.00	0.00
Alt 1a Year 2 (2003-2004) and beyond	0.00	47.16	0.00	0.00	52.84	0.00	0.00
Alt 1b Year 1 (2002-2003)	99.27	0.35	0.00	0.00	0.38	0.00	0.00
Alt 1b Year 2 (2003-3004)	98.55	0.69	0.00	0.00	0.76	0.00	0.00
Alt 1b Year 3 (2004-2005) and beyond	0.00	47.16	0.00	0.00	52.84	0.00	0.00
Alt 2 Year 1 (2002-2003)	99.14	0.40	0.00	0.00	0.47	0.00	0.00
Alt 2 Year 2 (2003-3004)	99.17	0.38	0.00	0.00	0.45	0.00	0.00
Alt 2 Year 3 (2004-2005) and beyond	99.06	0.44	0.00	0.00	0.50	0.00	0.00
Alt 3 Year 1 (2002-2003)	99.27	0.35	0.00	0.00	0.38	0.00	0.00
Alt 3 Year 2 (2003-3004) and beyond	79.06	16.28	0.00	0.00	4.66	0.00	0.00
Alt 4 Year 1 (2002-2003)	99.27	0.35	0.00	0.00	0.38	0.00	0.00
Alt 4 Year 2 (2003-3004) and beyond	93.16	3.37	0.00	0.00	3.47	0.00	0.00

None of the predicted 24-hr average PM_{10} concentrations (with the background concentration) exceed the National, Wyoming, and Montana AAQS for PM_{10}, which is 150 $\mu g/m^3$.

Similar to the maximum CO concentration results, all the generated maximum 24-hr average PM_{10} concentrations for the full implementation of Alternatives 2, 3, and 4 are higher than those of the full implementation years of Alternatives 1a and 1b. Moreover, all the maximum 24-hr average PM_{10} concentrations for the interim and full implementation years of Alternatives 1a, 1b, 2, 3, and 4 are lower than those of the existing conditions. Furthermore, the impacts of the full implementation years of Alternatives 1a and 1b show the highest decrease relative to the existing conditions, followed by Alternatives 3, 4, and 2.

For all the scenarios, snowmobile contributions to the generation of PM_{10} are the highest except in Alternatives 1a and 1b in which there is no snowmobile use and only snowcoaches travel in the park units.. It is worth noting that in the full implementation years of Alternative 1a and 1b, the contributions of snowplows to the generation of PM_{10} are higher than the contribution of snowcoaches. This is primarily due to the fact that the snowcoach traveling emission factor is lower than that of HDT and the snowcoach idle emission factor is negligible.

3.7. Air Quality Modeling Results for the West Entrance to Madison Roadway

3.7.1. CO Concentrations

Tables 10 to 12 present the CO modeling results for the West Entrance to Madison Roadway. Table 10 shows the predicted maximum 1-hr average CO concentrations, and Table 11 shows the calculated maximum 8-hr average CO concentrations. The percentages of the predicted maximum CO concentrations (i.e., without the background concentration) to the predicted maximum CO concentrations for the existing conditions also are provided. The percent contributions of each vehicle type, including snowplows (HDT), to the generation of CO are presented in Table 12.

Table 10. Maximum 1-hour Average CO Concentrations at the West Entrance to Madison Roadway

Alternative	1-hr Maximum Concentration (w/o bkgd) (ppm)	1-hr Maximum Concentration (w/ bkgd) (ppm)	Percent Relative to Existing Conditions (w/o bkgd)
Existing Conditions (2001-2002)	10.80	11.45	100.00
Alt 1a Year 1 (2002-2003)	5.40	6.05	50.00
Alt 1a Year 2 (2003-2004) and beyond	0.50	1.15	4.63
Alt 1b Year 1 (2002-2003)	10.80	11.45	100.00
Alt 1b Year 2 (2003-3004)	5.40	6.05	50.00
Alt 1b Year 3 (2004-2005) and beyond	0.50	1.15	4.63
Alt 2 Year 1 (2002-2003)	7.00	7.65	64.81
Alt 2 Year 2 (2003-3004)	7.30	7.95	67.59
Alt 2 Year 3 (2004-2005) and beyond	5.50	6.15	50.93
Alt 3 Year 1 (2002-2003)	10.80	11.45	100.00
Alt 3 Year 2 (2003-3004) and beyond	1.20	1.85	11.11
Alt 4 Year 1 (2002-2003)	10.80	11.45	100.00
Alt 4 Year 2 (2003-3004) and beyond	1.90	2.55	17.59

Notes: A percent equal to 100 means equal concentrations.
A percent less than 100 means a decrease in concentration.
A percent greater than 100 means an increase in concentration.

Table 11. Maximum 8-hour Average CO Concentrations at the West Entrance to Madison Roadway

Alternative	8-hr Maximum Concentration (w/o bkgd) (ppm)	8-hr Maximum Concentration (w/ bkgd) (ppm)	Percent Relative to Existing Conditions (w/o bkgd)
Existing Conditions (2001-2002)	7.56	8.02	100.00
Alt 1a Year 1 (2002-2003)	3.78	4.24	50.00
Alt 1a Year 2 (2003-2004) and beyond	0.35	0.81	4.63
Alt 1b Year 1 (2002-2003)	7.56	8.02	100.00
Alt 1b Year 2 (2003-3004)	3.78	4.24	50.00
Alt 1b Year 3 (2004-2005) and beyond	0.35	0.81	4.63
Alt 2 Year 1 (2002-2003)	4.90	5.36	64.81
Alt 2 Year 2 (2003-3004)	5.11	5.57	67.59
Alt 2 Year 3 (2004-2005) and beyond	3.85	4.31	50.93
Alt 3 Year 1 (2002-2003)	7.56	8.02	100.00
Alt 3 Year 2 (2003-3004) and beyond	0.84	1.30	11.11
Alt 4 Year 1 (2002-2003)	7.56	8.02	100.00
Alt 4 Year 2 (2003-3004) and beyond	1.33	1.79	17.59

Notes: A percent equal to 100 means equal concentrations.
A percent less than 100 means a decrease in concentration.
A percent greater than 100 means an increase in concentration.

Table 12. Contributions to CO Concentrations at the West Entrance to Madison Roadway

Alternative	Contribution (percent)						
	SM	SC	Auto	LDT	HDT	Bus	Van
Existing Conditions (2001-2002)	99.51	0.47	0.00	0.00	0.02	0.00	0.00
Alt 1a Year 1 (2002-2003)	99.03	0.94	0.00	0.00	0.03	0.00	0.00
Alt 1a Year 2 (2003-2004) and beyond	0.00	99.64	0.00	0.00	0.36	0.00	0.00
Alt 1b Year 1 (2002-2003)	99.51	0.47	0.00	0.00	0.02	0.00	0.00
Alt 1b Year 2 (2003-3004)	99.03	0.94	0.00	0.00	0.03	0.00	0.00
Alt 1b Year 3 (2004-2005) and beyond	0.00	99.64	0.00	0.00	0.36	0.00	0.00
Alt 2 Year 1 (2002-2003)	99.25	0.73	0.00	0.00	0.03	0.00	0.00
Alt 2 Year 2 (2003-3004)	99.28	0.70	0.00	0.00	0.02	0.00	0.00
Alt 2 Year 3 (2004-2005) and beyond	98.96	1.01	0.00	0.00	0.03	0.00	0.00
Alt 3 Year 1 (2002-2003)	99.51	0.47	0.00	0.00	0.02	0.00	0.00
Alt 3 Year 2 (2003-3004) and beyond	85.25	14.61	0.00	0.00	0.14	0.00	0.00
Alt 4 Year 1 (2002-2003)	99.51	0.47	0.00	0.00	0.02	0.00	0.00
Alt 4 Year 2 (2003-3004) and beyond	97.48	2.42	0.00	0.00	0.10	0.00	0.00

None of the predicted 1-hr average CO concentrations (with the background concentration) exceed the Montana AAQS for CO of 23 ppm, and none exceeds the Wyoming or National AAQS, which is 35 ppm. Similarly, none of the calculated 8-hr average CO concentrations (with the background concentration) exceed the National, Wyoming, and Montana AAQS for CO, which is 9 ppm.

All the maximum 1-hr average and 8-hr average CO concentrations for the full implementation years of Alternatives 2, 3, and 4 are higher than those of the full implementation years of Alternatives 1a and 1b. Moreover, all the maximum 1-hr average and 8-hr average CO concentrations for the interim and full implementation years of Alternatives 1a, 1b, 2, 3, and 4 are lower than those of the existing conditions. Furthermore, the impacts of the full implementation years of Alternatives 1a and 1b show the highest decrease relative to the existing conditions, followed by Alternatives 3, 4 and 2.

For all the scenarios, snowmobile contributions to the generation of CO are the highest except in Alternatives 1a and 1b in which there is no snowmobile use and only snowcoaches travel in the park units.

3.7.2. PM_{10} Concentrations

Tables 13 presents the PM_{10} modeling results for the West Entrance to Madison Roadway. It shows the predicted maximum 1-hr average PM_{10} concentrations and the calculated maximum

24-hr average PM_{10} concentrations. The percentages of the predicted maximum PM_{10} concentrations (i.e., without the background concentration) to the predicted maximum PM_{10} concentrations for the existing conditions also are provided. The percent contributions of each vehicle type, including snowplows (HDT), to the generation of PM_{10} are presented in Table 14.

Table 13. Maximum PM_{10} Concentrations at the West Entrance to Madison Roadway

Alternative	1-hr Maximum Concentration (w/o bkgd) ($\mu g/m^3$)	24-hr Maximum Concentration (w/o bkgd) ($\mu g/m^3$)	24-hr Maximum Concentration (w/ bkgd) ($\mu g/m^3$)	Percent Relative to 24-hr Maximum Existing Conditions (w/o bkgd)
Existing Conditions (2001-2002)	63.00	25.20	30.20	100.00
Alt 1a Year 1 (2002-2003)	32.00	12.80	17.80	50.79
Alt 1a Year 2 (2003-2004) and beyond	2.00	0.80	5.80	3.17
Alt 1b Year 1 (2002-2003)	63.00	25.20	30.20	100.00
Alt 1b Year 2 (2003-3004)	32.00	12.80	17.80	50.79
Alt 1b Year 3 (2004-2005) and beyond	2.00	0.80	5.80	3.17
Alt 2 Year 1 (2002-2003)	56.00	22.40	27.40	88.89
Alt 2 Year 2 (2003-3004)	58.00	23.20	28.20	92.06
Alt 2 Year 3 (2004-2005) and beyond	55.00	22.00	27.00	87.30
Alt 3 Year 1 (2002-2003)	63.00	25.20	30.20	100.00
Alt 3 Year 2 (2003-3004) and beyond	2.00	0.80	5.80	3.17
Alt 4 Year 1 (2002-2003)	63.00	25.20	30.20	100.00
Alt 4 Year 2 (2003-3004) and beyond	2.00	0.80	5.80	3.17

Notes: A percent equal to 100 means equal concentrations.
A percent less than 100 means a decrease in concentration.
A percent greater than 100 means an increase in concentration.

Table 14. Contributions to PM_{10} Concentrations at the West Entrance to Madison Roadway

Alternative	Contribution (percent)						
	SM	SC	Auto	LDT	HDT	Bus	Van
Existing Conditions (2001-2002)	99.42	0.36	0.00	0.00	0.21	0.00	0.00
Alt 1a Year 1 (2002-2003)	98.85	0.72	0.00	0.00	0.42	0.00	0.00
Alt 1a Year 2 (2003-2004) and beyond	0.00	94.33	0.00	0.00	5.67	0.00	0.00
Alt 1b Year 1 (2002-2003)	99.42	0.36	0.00	0.00	0.21	0.00	0.00
Alt 1b Year 2 (2003-3004)	98.85	0.72	0.00	0.00	0.42	0.00	0.00
Alt 1b Year 3 (2004-2005) and beyond	0.00	94.33	0.00	0.00	5.67	0.00	0.00
Alt 2 Year 1 (2002-2003)	99.34	0.42	0.00	0.00	0.24	0.00	0.00
Alt 2 Year 2 (2003-3004)	99.36	0.40	0.00	0.00	0.23	0.00	0.00
Alt 2 Year 3 (2004-2005) and beyond	99.29	0.47	0.00	0.00	0.25	0.00	0.00
Alt 3 Year 1 (2002-2003)	99.42	0.36	0.00	0.00	0.21	0.00	0.00
Alt 3 Year 2 (2003-3004) and beyond	49.71	43.34	0.00	0.00	6.94	0.00	0.00
Alt 4 Year 1 (2002-2003)	99.42	0.36	0.00	0.00	0.21	0.00	0.00
Alt 4 Year 2 (2003-3004) and beyond	82.66	10.44	0.00	0.00	6.90	0.00	0.00

None of the predicted 24-hr average PM_{10} concentrations (with the background concentration) exceed the National, Wyoming, and Montana AAQS for PM_{10}, which is 150 μg/m^3.

Similar to the maximum CO concentration results, all the generated maximum 24-hr average PM_{10} concentrations for the full implementation of Alternatives 2, 3, and 4 are higher than those of the full implementation years of Alternatives 1a and 1b. Moreover, all the maximum 24-hr average PM_{10} concentrations for the interim and full implementation years of Alternatives 1a, 1b, 2, 3, and 4 are lower than those of the existing conditions. Furthermore, the impacts of the full implementation years of Alternatives 1a and 1b show the highest decrease relative to the existing conditions, followed by Alternatives 3, 4, and 2.

For all the scenarios, snowmobile contributions to the generation of PM_{10} are the highest except in Alternatives 1a and 1b in which there is no snowmobile use and only snowcoach travel in the park units.

3.8. Air Quality Modeling Results for the Flagg Ranch to Colter Bay Roadway

3.8.1. CO Concentrations

Tables 15 to 17 present the CO modeling results for the Flagg Ranch to Colter Bay Roadway. Table 15 shows the predicted maximum 1-hr average CO concentrations, and Table 16 shows the calculated maximum 8-hr average CO concentrations. The percentages of the predicted maximum CO concentrations (i.e., without the background concentration) to the predicted maximum CO concentrations for the existing conditions also are provided. The percent contributions of each vehicle type, including snowplows (HDT), to the generation of CO are presented in Table 17.

Table 15. Maximum 1-hour average CO Concentrations at the Flagg Ranch to Colter Bay Roadway

Alternative	1-hr Maximum Concentration (w/o bkgd) (ppm)	1-hr Maximum Concentration (w/ bkgd) (ppm)	Percent Relative to Existing Conditions (w/o bkgd)
Existing Conditions (2001-2002)	0.70	1.35	100.00
Alt 1a Year 1 (2002-2003)	0.70	1.35	100.00
Alt 1a Year 2 (2003-2004) and beyond	0.20	0.85	28.57
Alt 1b Year 1 (2002-2003)	0.70	1.35	100.00
Alt 1b Year 2 (2003-3004)	0.70	1.35	100.00
Alt 1b Year 3 (2004-2005) and beyond	0.20	0.85	28.57
Alt 2 Year 1 (2002-2003)	0.80	1.45	114.29
Alt 2 Year 2 (2003-3004)	1.00	1.65	142.86
Alt 2 Year 3 (2004-2005) and beyond	1.30	1.95	185.71
Alt 3 Year 1 (2002-2003)	0.70	1.35	100.00
Alt 3 Year 2 (2003-3004) and beyond	0.40	1.05	57.14
Alt 4 Year 1 (2002-2003)	0.70	1.35	100.00
Alt 4 Year 2 (2003-3004) and beyond	0.30	0.95	42.86

Notes: A percent equal to 100 means equal concentrations.
A percent less than 100 means a decrease in concentration.
A percent greater than 100 means an increase in concentration.

Table 16. Maximum 8-hour average CO Concentrations at the Flagg Ranch to Colter Bay Roadway

Alternative	8-hr Maximum Concentration (w/o bkgd) (ppm)	8-hr Maximum Concentration (w/ bkgd) (ppm)	Percent Relative to Existing Conditions (w/o bkgd)
Existing Conditions (2001-2002)	0.49	0.95	100.00
Alt 1a Year 1 (2002-2003)	0.49	0.95	100.00
Alt 1a Year 2 (2003-2004) and beyond	0.14	0.60	28.57
Alt 1b Year 1 (2002-2003)	0.49	0.95	100.00
Alt 1b Year 2 (2003-3004)	0.49	0.95	100.00
Alt 1b Year 3 (2004-2005) and beyond	0.14	0.60	28.57
Alt 2 Year 1 (2002-2003)	0.56	1.02	114.29
Alt 2 Year 2 (2003-3004)	0.70	1.16	142.86
Alt 2 Year 3 (2004-2005) and beyond	0.91	1.37	185.71
Alt 3 Year 1 (2002-2003)	0.49	0.95	100.00
Alt 3 Year 2 (2003-3004) and beyond	0.28	0.74	57.14
Alt 4 Year 1 (2002-2003)	0.49	0.95	100.00
Alt 4 Year 2 (2003-3004) and beyond	0.21	0.67	42.86

Notes: A percent equal to 100 means equal concentrations.
A percent less than 100 means a decrease in concentration.
A percent greater than 100 means an increase in concentration.

Table 17. Contributions to CO Concentrations at the Flagg Ranch to Colter Bay Roadway

Alternative	Contribution (percent)						
	SM	SC	Auto	LDT	HDT	Bus	Van
Existing Conditions (2001-2002)	71.36	0.00	8.76	17.71	0.27	0.45	1.46
Alt 1a Year 1 (2002-2003)	71.36	0.00	8.76	17.71	0.27	0.45	1.46
Alt 1a Year 2 (2003-2004) and beyond	0.00	98.92	0.00	0.00	1.08	0.00	0.00
Alt 1b Year 1 (2002-2003)	71.36	0.00	8.76	17.71	0.27	0.45	1.46
Alt 1b Year 2 (2003-3004)	71.36	0.00	8.76	17.71	0.27	0.45	1.46
Alt 1b Year 3 (2004-2005) and beyond	0.00	98.92	0.00	0.00	1.08	0.00	0.00
Alt 2 Year 1 (2002-2003)	73.65	0.00	8.06	16.29	0.25	0.41	1.34
Alt 2 Year 2 (2003-3004)	78.45	0.00	6.59	13.32	0.20	0.34	1.10
Alt 2 Year 3 (2004-2005) and beyond	99.73	0.00	0.00	0.00	0.27	0.00	0.00
Alt 3 Year 1 (2002-2003)	71.36	0.00	8.76	17.71	0.27	0.45	1.46
Alt 3 Year 2 (2003-3004) and beyond	99.43	0.00	0.00	0.00	0.57	0.00	0.00
Alt 4 Year 1 (2002-2003)	71.36	0.00	8.76	17.71	0.27	0.45	1.46
Alt 4 Year 2 (2003-3004) and beyond	99.24	0.00	0.00	0.00	0.76	0.00	0.00

None of the predicted 1-hr average CO concentrations (with the background concentration) exceed the Montana AAQS for CO of 23 ppm, and none exceeds the Wyoming or National AAQS, which is 35 ppm. Similarly, none of the calculated 8-hr average CO concentrations (with the background concentration) exceed the National, Wyoming, and Montana AAQS for CO, which is 9 ppm.

All the maximum 1-hr average and 8-hr average CO concentrations for the full implementation years of Alternatives 2, 3, and 4 are higher than those of the full implementation years of Alternatives 1a and 1b. Moreover, all the maximum 1-hr average and 8-hr average CO concentrations for the interim and full implementation years of Alternatives 1a, 1b, 3, and 4 are lower than those of the existing conditions. However, all the maximum 1-hr average and 8-hr average CO concentrations for the interim and full implementation years of Alternative 2 are higher than those of the existing conditions. Furthermore, the impacts of the full implementation years of Alternatives 1a and 1b show the highest decrease relative to the existing conditions, followed by Alternatives 4 and 2 while that of Alternative 2 shows an increase. This primarily due to the high number of snowmobiles in Alternative 2 (see Appendix C).

For all the scenarios, snowmobile contributions to the generation of CO are the highest except in Alternatives 1a and 1b in which there is no snowmobile use and only snowcoaches travel in the park units.

3.8.2. PM_{10} Concentrations

Tables 18 presents the PM_{10} modeling results for the Flagg Ranch to Colter Bay Roadway. It shows the predicted maximum 1-hr average PM_{10} concentrations and the calculated maximum 24-hr average PM_{10} concentrations. The percentages of the predicted maximum PM_{10} concentrations (i.e., without the background concentration) to the predicted maximum PM_{10} concentrations for the existing conditions also are provided. The percent contributions of each vehicle type, including snowplows (HDT), to the generation of PM_{10} are presented in Table 19.

Table 18. Maximum PM_{10} Concentrations at the Flagg Ranch to Colter Bay Roadway

Alternative	1-hr Maximum Concentration (w/o bkgd) ($\mu g/m^3$)	24-hr Maximum Concentration (w/o bkgd) ($\mu g/m^3$)	24-hr Maximum Concentration (w/ bkgd) ($\mu g/m^3$)	Percent Relative to 24-hr Maximum Existing Conditions (w/o bkgd)
Existing Conditions (2001-2002)	4.00	1.60	6.60	100.00
Alt 1a Year 1 (2002-2003)	4.00	1.60	6.60	100.00
Alt 1a Year 2 (2003-2004) and beyond	1.00	0.40	5.40	25.00
Alt 1b Year 1 (2002-2003)	4.00	1.60	6.60	100.00
Alt 1b Year 2 (2003-3004)	4.00	1.60	6.60	100.00
Alt 1b Year 3 (2004-2005) and beyond	1.00	0.40	5.40	25.00
Alt 2 Year 1 (2002-2003)	5.00	2.00	7.00	125.00
Alt 2 Year 2 (2003-3004)	7.00	2.80	7.80	175.00
Alt 2 Year 3 (2004-2005) and beyond	8.00	3.20	8.20	200.00
Alt 3 Year 1 (2002-2003)	4.00	1.60	6.60	100.00
Alt 3 Year 2 (2003-3004) and beyond	0.00	0.00	5.00	0.00
Alt 4 Year 1 (2002-2003)	4.00	1.60	6.60	100.00
Alt 4 Year 2 (2003-3004) and beyond	0.00	0.00	5.00	0.00

Notes: A percent equal to 100 means equal concentrations.
A percent less than 100 means a decrease in concentration.
A percent greater than 100 means an increase in concentration.

Table 19. Contributions to PM_{10} Concentrations at the Flagg Ranch to Colter Bay Roadway

Alternative	Contribution (percent)						
	SM	SC	Auto	LDT	HDT	Bus	Van
Existing Conditions (2001-2002)	83.22	0.00	2.64	4.24	4.04	5.47	0.39
Alt 1a Year 1 (2002-2003)	83.22	0.00	2.64	4.24	4.04	5.47	0.39
Alt 1a Year 2 (2003-2004) and beyond	0.00	84.58	0.00	0.00	15.42	0.00	0.00
Alt 1b Year 1 (2002-2003)	83.22	0.00	2.64	4.24	4.04	5.47	0.39
Alt 1b Year 2 (2003-3004)	83.22	0.00	2.64	4.24	4.04	5.47	0.39
Alt 1b Year 3 (2004-2005) and beyond	0.00	84.58	0.00	0.00	15.42	0.00	0.00
Alt 2 Year 1 (2002-2003)	88.20	0.00	8.06	16.29	0.25	0.41	1.34
Alt 2 Year 2 (2003-3004)	90.69	0.00	1.46	2.35	2.24	3.03	0.22
Alt 2 Year 3 (2004-2005) and beyond	97.93	0.00	0.00	0.00	2.07	0.00	0.00
Alt 3 Year 1 (2002-2003)	83.22	0.00	2.64	4.24	4.04	5.47	0.39
Alt 3 Year 2 (2003-3004) and beyond	67.04	0.00	0.00	0.00	32.96	0.00	0.00
Alt 4 Year 1 (2002-2003)	83.22	0.00	2.64	4.24	4.04	5.47	0.39
Alt 4 Year 2 (2003-3004) and beyond	60.40	0.00	0.00	0.00	39.60	0.00	0.00

None of the predicted 24-hr average PM_{10} concentrations (with the background concentration) exceed the National, Wyoming, and Montana AAQS for PM_{10}, which is 150 $\mu g/m^3$.

All the maximum 24-hr average PM_{10} concentrations for the full implementation years of Alternatives 3 and 4 are equal to zero (0) while those of the full implementation years of Alternatives 1a and 1b are equal to one (1). This is due to the magnitude of the emission factors. There are only 17 snowcoaches in Alternative 1a and 1b with a traveling PM_{10} emission factor of 0.279 g/mile. On the other hand there are at least 44 snowmobiles in Alternatives 3 and 4 but the traveling emission factor is only 0.03 g/mile. Moreover, all the maximum 24-hr average PM_{10} concentrations for the interim and full implementation years of Alternatives 1a, 1b, 3, and 4 are lower than those of the existing conditions. However, all the maximum 24-hr average PM_{10} concentrations for the interim and full implementation years of Alternative 2 are higher than those of the existing conditions. Furthermore, the impacts of the full implementation years of Alternatives 3 and 4 show the highest decrease relative to the existing conditions, followed by Alternatives 1a and 1b while that of Alternative 2 show an increase. This primarily due to the high number of snowmobiles in Alternative 2 (see Appendix C).

For all the scenarios, snowmobile contributions to the generation of PM_{10} are the highest except in Alternatives 1a and 1b in which there is no snowmobile use and only snowcoach travel in the park units.

3.9. Air Quality Modeling Results for the Mammoth to Northeast Entrance Roadway

3.9.1. CO Concentrations

Tables 20 to 22 present the CO modeling results for the Mammoth to Northeast Entrance Roadway. Table 20 shows the predicted maximum 1-hr average CO concentrations, and Table 21 shows the calculated maximum 8-hr average CO concentrations. The percentages of the predicted maximum CO concentrations (i.e., without the background concentration) to the predicted maximum CO concentrations for the existing conditions also are provided. The percent contributions of each vehicle type, including snowplows (HDT), to the generation of CO are presented in Table 22.

Table 20. Maximum 1-hour average CO Concentrations at the Mammoth to Northeast Entrance Roadway

Alternative	1-hr Maximum Concentration (w/o bkgd) (ppm)	1-hr Maximum Concentration (w/ bkgd) (ppm)	Percent Relative to Existing Conditions (w/o bkgd)
Existing Conditions (2001-2002)	0.10	0.75	100.00
Alt 1a Year 1 (2002-2003)	0.10	0.75	100.00
Alt 1a Year 2 (2003-2004) and beyond	0.10	0.75	100.00
Alt 1b Year 1 (2002-2003)	0.10	0.75	100.00
Alt 1b Year 2 (2003-3004)	0.10	0.75	100.00
Alt 1b Year 3 (2004-2005) and beyond	0.10	0.75	100.00
Alt 2 Year 1 (2002-2003)	0.10	0.75	100.00
Alt 2 Year 2 (2003-3004)	0.10	0.75	100.00
Alt 2 Year 3 (2004-2005) and beyond	0.10	0.75	100.00
Alt 3 Year 1 (2002-2003)	0.10	0.75	100.00
Alt 3 Year 2 (2003-3004) and beyond	0.10	0.75	100.00
Alt 4 Year 1 (2002-2003)	0.10	0.75	100.00
Alt 4 Year 2 (2003-3004) and beyond	0.10	0.75	100.00

Notes: A percent equal to 100 means equal concentrations.
A percent less than 100 means a decrease in concentration.
A percent greater than 100 means an increase in concentration.

Table 21. Maximum 8-hour Average CO Concentrations at the Mammoth to Northeast Entrance Roadway

Alternative	8-hr Maximum Concentration (w/o bkgd) (ppm)	8-hr Maximum Concentration (w/ bkgd) (ppm)	Percent Relative to Existing Conditions (w/o bkgd)
Existing Conditions (2001-2002)	0.07	0.53	100.00
Alt 1a Year 1 (2002-2003)	0.07	0.53	100.00
Alt 1a Year 2 (2003-2004) and beyond	0.07	0.53	100.00
Alt 1b Year 1 (2002-2003)	0.07	0.53	100.00
Alt 1b Year 2 (2003-3004)	0.07	0.53	100.00
Alt 1b Year 3 (2004-2005) and beyond	0.07	0.53	100.00
Alt 2 Year 1 (2002-2003)	0.07	0.53	100.00
Alt 2 Year 2 (2003-3004)	0.07	0.53	100.00
Alt 2 Year 3 (2004-2005) and beyond	0.07	0.53	100.00
Alt 3 Year 1 (2002-2003)	0.07	0.53	100.00
Alt 3 Year 2 (2003-3004) and beyond	0.07	0.53	100.00
Alt 4 Year 1 (2002-2003)	0.07	0.53	100.00
Alt 4 Year 2 (2003-3004) and beyond	0.07	0.53	100.00

Notes: A percent equal to 100 means equal concentrations.
A percent less than 100 means a decrease in concentration.
A percent greater than 100 means an increase in concentration.

Table 22. Contributions to CO Concentrations at the Mammoth to Northeast Entrance Roadway

Alternative	Contribution (percent)						
	SM	SC	Auto	LDT	HDT	Bus	Van
Existing Conditions (2001-2002)	0.00	0.00	31.26	63.16	1.35	0.99	3.24
Alt 1a Year 1 (2002-2003)							
Alt 1a Year 2 (2003-2004) and beyond	0.00	0.00	31.26	63.16	1.35	0.99	3.24
Alt 1b Year 1 (2002-2003)	0.00	0.00	31.26	63.16	1.35	0.99	3.24
Alt 1b Year 2 (2003-3004)	0.00	0.00	31.26	63.16	1.35	0.99	3.24
Alt 1b Year 3 (2004-2005) and beyond	0.00	0.00	31.26	63.16	1.35	0.99	3.24
Alt 2 Year 1 (2002-2003)	0.00	0.00	31.26	63.16	1.35	0.99	3.24
Alt 2 Year 2 (2003-3004)	0.00	0.00	31.26	63.16	1.35	0.99	3.24
Alt 2 Year 3 (2004-2005) and beyond	0.00	0.00	31.26	63.16	1.35	0.99	3.24
Alt 3 Year 1 (2002-2003)	0.00	0.00	31.26	63.16	1.35	0.99	3.24
Alt 3 Year 2 (2003-3004) and beyond	0.00	0.00	31.26	63.16	1.35	0.99	3.24
Alt 4 Year 1 (2002-2003)	0.00	0.00	31.26	63.16	1.35	0.99	3.24
Alt 4 Year 2 (2003-3004) and beyond	0.00	0.00	31.26	63.16	1.35	0.99	3.24

This road segment is used by wheeled-vehicles only, and it was assumed that the number and emission factors of the wheeled vehicle fleet do not change yearly. Therefore the impacts are the same for each year. None of the predicted 1-hr average CO concentrations (with the background concentration) exceed the Montana AAQS for CO of 23 ppm, and none exceeds the Wyoming or National AAQS, which is 35 ppm. Similarly, none of the calculated 8-hr average CO concentrations (with the background concentration) exceed the National, Wyoming, and

Montana AAQS for CO, which is 9 ppm. Light-duty Trucks (LDT) contribute the most in the generation of CO.

3.9.2. PM_{10} Concentrations

Table 23 presents the PM_{10} modeling results for the Mammoth to Northeast Entrance Roadway. It shows the predicted maximum 1-hr average PM_{10} concentrations and the calculated maximum 24-hr average PM_{10} concentrations. The percentages of the predicted maximum PM_{10} concentrations (i.e., without the background concentration) to the predicted maximum PM_{10} concentrations for the existing conditions also are provided. The percent contributions of each vehicle type, including snowplows (HDT), to the generation of PM_{10} are presented in Table 24.

Table 23. Maximum PM_{10} Concentrations at the Mammoth to Northeast Entrance Roadway

Alternative	1-hr Maximum Concentration (w/o bkgd) (μg/m³)	24-hr Maximum Concentration (w/o bkgd) (μg/m³)	24-hr Maximum Concentration (w/ bkgd) (μg/m³)	Percent Relative to 24-hr Maximum Existing Conditions (w/o bkgd)
Existing Conditions (2001-2002)	0.00	0.00	0.00	100.00
Alt 1a Year 1 (2002-2003)	0.00	0.00	0.00	100.00
Alt 1a Year 2 (2003-2004) and beyond	0.00	0.00	0.00	100.00
Alt 1b Year 1 (2002-2003)	0.00	0.00	0.00	100.00
Alt 1b Year 2 (2003-3004)	0.00	0.00	0.00	100.00
Alt 1b Year 3 (2004-2005) and beyond	0.00	0.00	0.00	100.00
Alt 2 Year 1 (2002-2003)	0.00	0.00	0.00	100.00
Alt 2 Year 2 (2003-3004)	0.00	0.00	0.00	100.00
Alt 2 Year 3 (2004-2005) and beyond	0.00	0.00	0.00	100.00
Alt 3 Year 1 (2002-2003)	0.00	0.00	0.00	100.00
Alt 3 Year 2 (2003-3004) and beyond	0.00	0.00	0.00	100.00
Alt 4 Year 1 (2002-2003)	0.00	0.00	0.00	100.00
Alt 4 Year 2 (2003-3004) and beyond	0.00	0.00	0.00	100.00

Notes: A percent equal to 100 means equal concentrations.
A percent less than 100 means a decrease in concentration.
A percent greater than 100 means an increase in concentration.

Table 24. Contributions to PM_{10} Concentrations at the Mammoth to Northeast Entrance Roadway

Alternative	Contribution (percent)						
	SM	SC	Auto	LDT	HDT	Bus	Van
Existing Conditions (2001-2002)	0.00	0.00	16.26	26.13	35.11	20.99	1.50
Alt 1a Year 1 (2002-2003)	0.00	0.00	16.26	26.13	35.11	20.99	1.50
Alt 1a Year 2 (2003-2004) and beyond	0.00	0.00	16.26	26.13	35.11	20.99	1.50
Alt 1b Year 1 (2002-2003)	0.00	0.00	16.26	26.13	35.11	20.99	1.50
Alt 1b Year 2 (2003-3004)	0.00	0.00	16.26	26.13	35.11	20.99	1.50
Alt 1b Year 3 (2004-2005) and beyond	0.00	0.00	16.26	26.13	35.11	20.99	1.50
Alt 2 Year 1 (2002-2003)	0.00	0.00	16.26	26.13	35.11	20.99	1.50
Alt 2 Year 2 (2003-3004)	0.00	0.00	16.26	26.13	35.11	20.99	1.50
Alt 2 Year 3 (2004-2005) and beyond	0.00	0.00	16.26	26.13	35.11	20.99	1.50
Alt 3 Year 1 (2002-2003)	0.00	0.00	16.26	26.13	35.11	20.99	1.50
Alt 3 Year 2 (2003-3004) and beyond	0.00	0.00	16.26	26.13	35.11	20.99	1.50
Alt 4 Year 1 (2002-2003)	0.00	0.00	16.26	26.13	35.11	20.99	1.50
Alt 4 Year 2 (2003-3004) and beyond	0.00	0.00	16.26	26.13	35.11	20.99	1.50

Similar to CO concentrations, this road segment is used by wheeled-vehicles only, and it was assumed that the number and the emission factors of the wheeled vehicle fleet do not change yearly. Therefore, the impacts are the same for each year and are equal to zero (0) due to the combination of low vehicle number and extremely low composite traveling PM_{10} emission factor (see Appendix C). Consequently, none of the predicted 24-hr average PM_{10} concentrations (with the background concentration) exceed the National, Wyoming, and Montana AAQS for PM_{10}, which is 150 $\mu g/m^3$.

3.10. Air Quality Modeling Results for the Old Faithful Staging Area

3.10.1. CO Concentrations

Tables 25 to 27 present the CO modeling results for the Old Faithful Staging Area. Table 25 shows the predicted maximum 1-hr average CO concentrations, and Table 26 shows the predicted maximum 8-hr average CO concentrations. The percentages of the predicted maximum CO concentrations (i.e., without the background concentration) to the predicted maximum CO concentrations for the existing conditions also are provided. The percent contributions of each vehicle type, including snowplows (HDT), to the generation of CO are presented in Table 27.

Table 25. Maximum 1-hour Average CO Concentrations at the Old Faithful Staging Area

Alternative	1-hr Maximum Concentration (w/o bkgd) (ppm)	1-hr Maximum Concentration (w/ bkgd) (ppm)	Percent Relative to Existing Conditions (w/o bkgd)
Existing Conditions (2001-2002)	28.48	29.13	100.00
Alt 1a Year 1 (2002-2003)	14.69	15.34	51.58
Alt 1a Year 2 (2003-2004) and beyond	6.92	7.57	24.30
Alt 1b Year 1 (2002-2003)	28.48	29.13	100.00
Alt 1b Year 2 (2003-3004)	14.69	15.34	51.58
Alt 1b Year 3 (2004-2005) and beyond	6.92	7.57	24.30
Alt 2 Year 1 (2002-2003)	20.73	21.38	72.78
Alt 2 Year 2 (2003-3004)	21.54	22.19	75.63
Alt 2 Year 3 (2004-2005) and beyond	18.03	18.68	63.29
Alt 3 Year 1 (2002-2003)	28.48	29.13	100.00
Alt 3 Year 2 (2003-3004) and beyond	13.52	14.17	47.47
Alt 4 Year 1 (2002-2003)	28.48	29.13	100.00
Alt 4 Year 2 (2003-3004) and beyond	12.62	13.27	44.30

Notes: A percent equal to 100 means equal concentrations.
A percent less than 100 means a decrease in concentration.
A percent greater than 100 means an increase in concentration.

Table 26. Maximum 8-hour Average CO Concentrations at the Old Faithful Staging Area

Alternative	8-hr Maximum Concentration (w/o bkgd) (ppm)	8-hr Maximum Concentration (w/ bkgd) (ppm)	Percent Relative to Existing Conditions (w/o bkgd)
Existing Conditions (2001-2002)	4.75	5.20	100.00
Alt 1a Year 1 (2002-2003)	2.45	2.90	51.58
Alt 1a Year 2 (2003-2004) and beyond	1.15	1.61	24.30
Alt 1b Year 1 (2002-2003)	4.75	5.20	100.00
Alt 1b Year 2 (2003-3004)	2.45	2.90	51.58
Alt 1b Year 3 (2004-2005) and beyond	1.15	1.61	24.30
Alt 2 Year 1 (2002-2003)	3.45	3.91	72.78
Alt 2 Year 2 (2003-3004)	3.59	4.05	75.63
Alt 2 Year 3 (2004-2005) and beyond	3.00	3.46	63.29
Alt 3 Year 1 (2002-2003)	4.75	5.20	100.00
Alt 3 Year 2 (2003-3004) and beyond	2.25	2.71	47.47
Alt 4 Year 1 (2002-2003)	4.75	5.20	100.00
Alt 4 Year 2 (2003-3004) and beyond	2.10	2.56	44.30

Notes: A percent equal to 100 means equal concentrations.
A percent less than 100 means a decrease in concentration.
A percent greater than 100 means an increase in concentration.

Table 27. Contributions to CO Concentrations at the Old Faithful Staging Area

Alternative	Contribution (percent)						
	SM	SC	Auto	LDT	HDT	Bus	Van
Existing Conditions (2001-2002)	96.62	3.07	0.00	0.00	0.31	0.00	0.00
Alt 1a Year 1 (2002-2003)	93.45	5.94	0.00	0.00	0.60	0.00	0.00
Alt 1a Year 2 (2003-2004) and beyond	0.00	98.71	0.00	0.00	1.29	0.00	0.00
Alt 1b Year 1 (2002-2003)	96.62	3.07	0.00	0.00	0.31	0.00	0.00
Alt 1b Year 2 (2003-3004)	93.45	5.94	0.00	0.00	0.60	0.00	0.00
Alt 1b Year 3 (2004-2005) and beyond	0.00	98.71	0.00	0.00	1.29	0.00	0.00
Alt 2 Year 1 (2002-2003)	95.35	4.22	0.00	0.00	0.43	0.00	0.00
Alt 2 Year 2 (2003-3004)	95.52	4.07	0.00	0.00	0.41	0.00	0.00
Alt 2 Year 3 (2004-2005) and beyond	94.85	4.66	0.00	0.00	0.49	0.00	0.00
Alt 3 Year 1 (2002-2003)	96.62	3.07	0.00	0.00	0.31	0.00	0.00
Alt 3 Year 2 (2003-3004) and beyond	82.50	16.85	0.00	0.00	0.66	0.00	0.00
Alt 4 Year 1 (2002-2003)	96.62	3.07	0.00	0.00	0.31	0.00	0.00
Alt 4 Year 2 (2003-3004) and beyond	90.27	9.03	0.00	0.00	0.71	0.00	0.00

None of the predicted 1-hr average CO concentrations (with the background concentration) exceed the Montana AAQS for CO of 23 ppm, and none exceeds the Wyoming or National AAQS, which is 35 ppm. Similarly, none of the calculated 8-hr average CO concentrations (with the background concentration) exceed the National, Wyoming, and Montana AAQS for CO, which is 9 ppm.

All the maximum 1-hr average and 8-hr average CO concentrations for the full implementation years of Alternatives 2, 3, and 4 are higher than those of the full implementation years of Alternatives 1a and 1b. Moreover, all the maximum 1-hr average and 8-hr average CO concentrations for the interim and full implementation years of Alternatives 1a, 1b, 2, 3, and 4 are lower than those of the existing conditions. Furthermore, the impacts of the full implementation years of Alternatives 1a and 1b show the highest decrease relative to the existing conditions, followed by Alternatives 4, 3, and 2.

For all the scenarios, snowmobile contributions to the generation of CO are the highest except in Alternatives 1a and 1b in which there is no snowmobile use and only snowcoaches travel in the park units.

3.10.2. PM_{10} Concentrations

Tables 28 presents the PM_{10} modeling results for the Old Faithful Staging Area. It shows the predicted maximum 24-hr average PM_{10} concentrations. The percentages of the predicted maximum PM_{10} concentrations (i.e., without the background concentration) to the predicted maximum PM_{10} concentrations for the existing conditions also are provided. The percent contributions of each vehicle type, including snowplows (HDT), to the generation of PM_{10} are presented in Table 29.

Table 28. Maximum PM_{10} Concentrations at the Old Faithful Staging Area

Alternative	24-hr Maximum Concentration (w/o bkgd) ($\mu g/m^3$)	24-hr Maximum Concentration (w/ bkgd) ($\mu g/m^3$)	Percent Relative to 24-hr Maximum Existing Conditions (w/o bkgd)
Existing Conditions (2001-2002)	15.42	20.42	100.00
Alt 1a Year 1 (2002-2003)	7.74	12.74	50.19
Alt 1a Year 2 (2003-2004) and beyond	0.04	5.04	0.28
Alt 1b Year 1 (2002-2003)	15.42	20.42	100.00
Alt 1b Year 2 (2003-3004)	7.74	12.74	50.19
Alt 1b Year 3 (2004-2005) and beyond	0.04	5.04	0.28
Alt 2 Year 1 (2002-2003)	11.70	16.70	75.84
Alt 2 Year 2 (2003-3004)	12.16	17.16	78.81
Alt 2 Year 3 (2004-2005) and beyond	10.49	15.49	68.03
Alt 3 Year 1 (2002-2003)	15.42	20.42	100.00
Alt 3 Year 2 (2003-3004) and beyond	2.43	7.43	15.72
Alt 4 Year 1 (2002-2003)	15.42	20.42	100.00
Alt 4 Year 2 (2003-3004) and beyond	2.47	7.47	16.02

Notes: A percent equal to 100 means equal concentrations.
A percent less than 100 means a decrease in concentration.
A percent greater than 100 means an increase in concentration.

Table 29. Contributions to PM_{10} Concentrations at the Old Faithful Staging Area

Alternative	Contribution (percent)						
	SM	SC	Auto	LDT	HDT	Bus	Van
Existing Conditions (2001-2002)	99.71	0.00	0.00	0.00	0.29	0.00	0.00
Alt 1a Year 1 (2002-2003)	99.43	0.00	0.00	0.00	0.57	0.00	0.00
Alt 1a Year 2 (2003-2004) and beyond	0.00	0.00	0.00	0.00	100.0	0.00	0.00
Alt 1b Year 1 (2002-2003)	99.71	0.00	0.00	0.00	0.29	0.00	0.00
Alt 1b Year 2 (2003-3004)	99.43	0.00	0.00	0.00	0.57	0.00	0.00
Alt 1b Year 3 (2004-2005) and beyond	0.00	0.00	0.00	0.00	100.0	0.00	0.00
Alt 2 Year 1 (2002-2003)	99.62	0.00	0.00	0.00	0.38	0.00	0.00
Alt 2 Year 2 (2003-3004)	99.64	0.00	0.00	0.00	0.36	0.00	0.00
Alt 2 Year 3 (2004-2005) and beyond	99.58	0.00	0.00	0.00	0.42	0.00	0.00
Alt 3 Year 1 (2002-2003)	99.71	0.00	0.00	0.00	0.29	0.00	0.00
Alt 3 Year 2 (2003-3004) and beyond	98.19	0.00	0.00	0.00	1.81	0.00	0.00
Alt 4 Year 1 (2002-2003)	99.71	0.00	0.00	0.00	0.29	0.00	0.00
Alt 4 Year 2 (2003-3004) and beyond	98.22	0.00	0.00	0.00	1.78	0.00	0.00

None of the predicted 24-hr average PM_{10} concentrations (with the background concentration) exceed the National, Wyoming, and Montana AAQS for PM_{10}, which is 150 µg/m^3.

Similar to the maximum CO concentration results, all the generated maximum 24-hr average PM_{10} concentrations for the full implementation of Alternatives 2, 3, and 4 are higher than those of the full implementation years of Alternatives 1a and 1b. Moreover, all the maximum 24-hr average PM_{10} concentrations for the interim and full implementation years of Alternatives 1a, 1b, 2, 3, and 4 are lower than those of the existing conditions. Furthermore, the impacts of the full implementation years of Alternatives 1a and 1b show the highest decrease relative to the existing conditions, followed by Alternatives 3, 4, and 2.

For all the scenarios, snowmobile contributions to the generation of PM_{10} are the highest except in Alternatives 1a and 1b in which there is no snowmobile use and only snowcoach travel in the park units. It is worth noting that HDT contribute to all the generated PM_{10} in the full implementation years of Alternatives 1a and 1b. This is due to the fact that the snowcoach PM_{10} idle emission factor is negligible.

3.11. Air Quality Modeling Results for the Flagg Ranch Staging Area

3.11.1. CO Concentrations

Tables 30 to 32 present the CO modeling results for the Flagg Ranch Staging Area Roadway. Table 30 shows the predicted maximum 1-hr average CO concentrations, and Table 31 shows the predicted maximum 8-hr average CO concentrations. The percentages of the predicted maximum CO concentrations (i.e., without the background concentration) to the predicted maximum CO concentrations for the existing conditions also are provided. The percent contributions of each vehicle type, including snowplows (HDT), to the generation of CO are presented in Table 32.

Table 30. Maximum 1-hour Average CO Concentrations at the Flagg Ranch Staging Area

Alternative	1-hr Maximum Concentration (w/o bkgd) (ppm)	1-hr Maximum Concentration (w/ bkgd) (ppm)	Percent Relative to Existing Conditions (w/o bkgd)
Existing Conditions (2001-2002)	19.63	20.29	100.00
Alt 1a Year 1 (2002-2003)	13.47	14.12	68.59
Alt 1a Year 2 (2003-2004) and beyond	5.31	5.96	27.05
Alt 1b Year 1 (2002-2003)	19.63	20.29	100.00
Alt 1b Year 2 (2003-3004)	13.47	14.12	68.59
Alt 1b Year 3 (2004-2005) and beyond	5.31	5.96	27.05
Alt 2 Year 1 (2002-2003)	19.13	19.78	97.44
Alt 2 Year 2 (2003-3004)	21.52	22.17	109.62
Alt 2 Year 3 (2004-2005) and beyond	13.97	14.62	71.15
Alt 3 Year 1 (2002-2003)	19.63	20.29	100.00
Alt 3 Year 2 (2003-3004) and beyond	15.10	15.75	76.92
Alt 4 Year 1 (2002-2003)	19.63	20.29	100.00
Alt 4 Year 2 (2003-3004) and beyond	10.07	10.72	51.28

Notes: A percent equal to 100 means equal concentrations.
A percent less than 100 means a decrease in concentration.
A percent greater than 100 means an increase in concentration.

Table 31. Maximum 8-hour Average CO Concentrations at the Flagg Ranch Staging Area

Alternative	8-hr Maximum Concentration (w/o bkgd) (ppm)	8-hr Maximum Concentration (w/ bkgd) (ppm)	Percent Relative to Existing Conditions (w/o bkgd)
Existing Conditions (2001-2002)	3.27	3.73	100.00
Alt 1a Year 1 (2002-2003)	2.24	2.70	68.59
Alt 1a Year 2 (2003-2004) and beyond	0.89	1.34	27.05
Alt 1b Year 1 (2002-2003)	3.27	3.73	100.00
Alt 1b Year 2 (2003-3004)	2.24	2.70	68.59
Alt 1b Year 3 (2004-2005) and beyond	0.89	1.34	27.05
Alt 2 Year 1 (2002-2003)	3.19	3.64	97.44
Alt 2 Year 2 (2003-3004)	5.59	4.04	109.62
Alt 2 Year 3 (2004-2005) and beyond	2.33	2.78	71.15
Alt 3 Year 1 (2002-2003)	3.27	3.73	100.00
Alt 3 Year 2 (2003-3004) and beyond	2.52	2.97	76.92
Alt 4 Year 1 (2002-2003)	3.27	3.73	100.00
Alt 4 Year 2 (2003-3004) and beyond	1.68	2.13	51.28

Notes: A percent equal to 100 means equal concentrations.
A percent less than 100 means a decrease in concentration.
A percent greater than 100 means an increase in concentration.

Table 32. Contributions to CO Concentrations at the Flagg Ranch Staging Area

Alternative	Contribution (percent)						
	SM	SC	Auto	LDT	HDT	Bus	Van
Existing Conditions (2001-2002)	63.06	1.84	10.58	21.33	0.63	0.59	1.96
Alt 1a Year 1 (2002-2003)	46.05	2.68	15.45	31.15	0.93	0.87	2.87
Alt 1a Year 2 (2003-2004) and beyond	0.00	97.66	0.00	0.00	2.34	0.00	0.00
Alt 1b Year 1 (2002-2003)	63.06	1.84	10.58	21.33	0.63	0.59	1.96
Alt 1b Year 2 (2003-3004)	46.05	2.68	15.45	31.15	0.93	0.87	2.87
Alt 1b Year 3 (2004-2005) and beyond	0.00	97.66	0.00	0.00	2.34	0.00	0.00
Alt 2 Year 1 (2002-2003)	62.22	1.88	10.82	21.81	0.65	0.61	2.01
Alt 2 Year 2 (2003-3004)	66.41	1.67	9.62	19.39	0.58	0.54	1.79
Alt 2 Year 3 (2004-2005) and beyond	97.92	1.20	0.00	0.00	0.89	0.00	0.00
Alt 3 Year 1 (2002-2003)	63.06	1.84	10.58	21.33	0.63	0.59	1.96
Alt 3 Year 2 (2003-3004) and beyond	96.41	2.77	0.00	0.00	0.82	0.00	0.00
Alt 4 Year 1 (2002-2003)	63.06	1.84	10.58	21.33	0.63	0.59	1.96
Alt 4 Year 2 (2003-3004) and beyond	95.44	3.32	0.00	0.00	1.23	0.00	0.00

None of the predicted 1-hr average CO concentrations (with the background concentration) exceed the Montana AAQS for CO of 23 ppm, and none exceeds the Wyoming or National AAQS, which is 35 ppm. Similarly, none of the calculated 8-hr average CO concentrations (with the background concentration) exceed the National, Wyoming, and Montana AAQS for CO, which is 9 ppm.

All the maximum 1-hr average and 8-hr average CO concentrations for the full implementation years of Alternatives 2, 3, and 4 are higher than those of the full implementation years of Alternatives 1a and 1b. Moreover, except for year 2 of alternative 2, all the maximum 1-hr average and 8-hr average CO concentrations for the interim and full implementation years of Alternatives 1a, 1b, 2, 3, and 4 are lower than those of the existing conditions. The results of year 2 of Alternative 2 are due to the high number of snowmobiles (see Appendix C). Furthermore, the impacts of the full implementation years of Alternatives 1a and 1b show the highest decrease relative to the existing conditions, followed by Alternatives 4, 2, and 3.

For all the scenarios, snowmobile contributions to the generation of CO are the highest except in Alternatives 1a and 1b in which there is no snowmobile use and only snowcoaches travel in the park units.

3.11.2. PM_{10} Concentrations

Table 33 presents the PM_{10} modeling results for the Flagg Ranch Staging Area. It shows the predicted maximum 24-hr average PM_{10} concentrations. The percentages of the predicted maximum PM_{10} concentrations (i.e., without the background concentration) to the predicted maximum PM_{10} concentration for the existing conditions also are provided. The percent contributions of each vehicle type, including snowplows (HDT), to the generation of PM_{10} are presented in Table 34.

Table 33. Maximum PM_{10} Concentrations at the Flagg Ranch Staging Area

Alternative	24-hr Maximum Concentration (w/o bkgd) ($\mu g/m^3$)	24-hr Maximum Concentration (w/ bkgd) ($\mu g/m^3$)	Percent Relative to 24-hr Maximum Existing Conditions (w/o bkgd)
Existing Conditions (2001-2002)	7.01	12.01	100.00
Alt 1a Year 1 (2002-2003)	3.56	8.56	50.86
Alt 1a Year 2 (2003-2004) and beyond	0.06	5.06	0.88
Alt 1b Year 1 (2002-2003)	7.01	12.01	100.00
Alt 1b Year 2 (2003-3004)	3.56	8.56	50.86
Alt 1b Year 3 (2004-2005) and beyond	0.06	5.06	0.88
Alt 2 Year 1 (2002-2003)	7.13	12.13	101.83
Alt 2 Year 2 (2003-3004)	8.57	13.57	122.29
Alt 2 Year 3 (2004-2005) and beyond	8.49	13.49	121.14
Alt 3 Year 1 (2002-2003)	7.01	12.01	100.00
Alt 3 Year 2 (2003-3004) and beyond	3.17	8.17	45.26
Alt 4 Year 1 (2002-2003)	7.01	12.01	100.00
Alt 4 Year 2 (2003-3004) and beyond	2.11	7.11	30.17

Notes: A percent equal to 100 means equal concentrations.
A percent less than 100 means a decrease in concentration.
A percent greater than 100 means an increase in concentration.

Table 34. Contributions to PM_{10} Concentrations at the Flagg Ranch Staging Area

Alternative	Contribution (percent)						
	SM	SC	Auto	LDT	HDT	Bus	Van
Existing Conditions (2001-2002)	98.31	0.00	0.00	0.00	0.88	0.82	0.00
Alt 1a Year 1 (2002-2003)	96.67	0.00	0.00	0.00	1.72	1.61	0.00
Alt 1a Year 2 (2003-2004) and beyond	0.00	0.00	0.00	0.00	100.00	0.00	0.00
Alt 1b Year 1 (2002-2003)	98.31	0.00	0.00	0.00	0.88	0.82	0.00
Alt 1b Year 2 (2003-3004)	96.67	0.00	0.00	0.00	1.72	1.61	0.00
Alt 1b Year 3 (2004-2005) and beyond	0.00	0.00	0.00	0.00	100.00	0.00	0.00
Alt 2 Year 1 (2002-2003)	98.34	0.00	0.00	0.00	0.86	0.80	0.00
Alt 2 Year 2 (2003-3004)	98.61	0.00	0.00	0.00	0.72	0.67	0.00
Alt 2 Year 3 (2004-2005) and beyond	99.28	0.00	0.00	0.00	0.72	0.00	0.00
Alt 3 Year 1 (2002-2003)	98.31	0.00	0.00	0.00	0.88	0.82	0.00
Alt 3 Year 2 (2003-3004) and beyond	98.07	0.00	0.00	0.00	1.93	0.00	0.00
Alt 4 Year 1 (2002-2003)	98.31	0.00	0.00	0.00	0.88	0.82	0.00
Alt 4 Year 2 (2003-3004) and beyond	97.10	0.00	0.00	0.00	2.90	0.00	0.00

None of the predicted 24-hr average PM_{10} concentrations (with the background concentration) exceed the National, Wyoming, and Montana AAQS for PM_{10}, which is 150 $\mu g/m^3$.

All the maximum 24-hr PM_{10} concentrations for the full implementation years of Alternatives 2, 3 and 4 are higher than those of the full implementation years of Alternatives 1a and 1b. Moreover, all the maximum 24-hr average PM_{10} concentrations for the interim and full implementation years of Alternatives 1a, 1b, 3 and 4 are lower than those of the existing conditions. However, all the maximum 24-hr average PM_{10} concentrations for the interim and full implementation years of Alternative 2 are higher than those of the existing conditions. Furthermore, the impacts of the full implementation years of Alternatives 1a and 1b show the highest decrease relative to the existing conditions, followed by Alternative 4, 3, and 2.

For all the scenarios, snowmobile contributions to the generation of PM_{10} are the highest except in Alternatives 1a and 1b in which there is no snowmobile use and only snowcoach travel in the park units. It is worth noting that HDT contribute to all the generated PM_{10} in the full implementation years of Alternatives 1a and 1b. This is due to the fact that the snowcoach PM_{10} idle emission factor is negligible.

4. PM_{10} PSD INCREMENT ANALYSIS

YELL is classified as a mandatory federal Class I area. Under the PSD provisions and implementing regulations for Class I areas, once baseline concentrations come under review by submission of a PSD pre-construction permit application for a major new or modified emissions source, only the smallest increment of certain pollutants (sulfur dioxide, nitrogen oxide, and particulate matter) may be added to the air by the proposed new source. In Class I areas, the significant level that must be exceeded by an existing stationary source, located within 90 km, to initiate the increment review process is 1.0 μg/m^3, 24-hour basis. After the increment baseline has been established by a major stationary source, all sources including mobile and fugitive sources, are to be included in determining the remaining increment. PSD increments are the maximum increases in ambient pollutant concentrations allowed over the baseline concentrations. The PM_{10} increments in Class I areas are 4.0 and 8.0 μg/m^3 for the annual and 24-hour averaging times, respectively.

A PM_{10} emission inventory and air quality analysis were performed for a defined impact area in YELL. The analysis evaluated the extent of the PSD increment consumption due to winter use activities relative to an established baseline date. Both the States of Montana and Wyoming have established PM_{10} baseline dates in YELL in 1979 (NPS, 2000a). In the 1978-1979 winter season, there were approximately 43,138 oversnow park visitors, including snowmobiles and snowcoach riders. Using data on mobile and area source activities for that year, the current conditions, and the full implementation year of each of the proposed alternatives, associated actual PM_{10} mass emissions rates were calculated. The changes in emissions over the baseline were then modeled in order to determine the maximum 24-hour and annual average ground level PM_{10} concentrations. Finally, these maximum concentrations were compared to the PM_{10} PSD increments in order to determine the extent of the increment consumption between the baseline date and the current conditions date and the full implementation date of each alternative. The methodology employed in this analysis reflects a screening-level analysis not intended for regulatory purposes. In the event that modeling results indicate that the increments are threatened, a more detailed regulatory analysis would be warranted.

4.1. Impact Area Determination

Previous PM_{10} air quality analyses, using peak hourly input data at six different locations within the three park units, have shown that the predicted 24-hr average maximum PM_{10} concentrations were the highest at the West Yellowstone Entrance (see Section 3). Therefore, the analysis focused on the West Yellowstone Entrance and its vicinity.

Based on the current conditions, a circular area with a radius extending from the West Yellowstone Entrance to the most distant point where a significant PM_{10} ambient impact occurred was determined and selected as the area of significant impact. The radius was determined from dispersion modeling results for the West Yellowstone Entrance only. The 24-hour average ground level PM_{10} concentrations were predicted using the EPA model CAL3QHCR (EPA, 1995). CAL3QHCR is and enhanced version of CAL3QHC that allows the capability to process a year of hourly meteorological data. It also incorporates the ISCST3 mixing height algorithm and various concentration averaging algorithms.

The emission factors presented in Section 3 and Appendices C and D were used. Five years (1987-1991) worth of winter season (December – March) of hourly surface and upper air meteorological data from the National Weather Service (NWS) station located in Great Falls International Airport, MT also were used. The terrain in the impact area was assumed rural, and its elevations assumed to be 500 ft. A 200-ft spacing Cartesian receptor grid starting outside the mixing zone and extending up to 2000 feet was used in the analysis.

The modeling results showed that the impact area radius of the West Yellowstone Entrance is only 300.00 m. This is primarily due to the characteristics of the sources and source strength. As a matter of fact, the PM_{10} sources at the West Yellowstone Entrance are only mobile sources (snowcoach and snowmobile) that release an exhaust stream at ground level, and their PM_{10} emission rates are relatively very low. Therefore, the ambient impacts would be in the immediate vicinity of the entrance itself. For the purpose of this screening-level analysis, the impact area was extended to include the whole town of West Yellowstone (i.e., a radius of approximately 3 km).

4.2. Emission Inventory for Modeling

Investigations of the PM_{10} emissions sources indicated that there were no major point sources in this impact area. The main sources of PM_{10} were woodstoves located in the town of West

Yellowstone, portions of highways 287 and 20, portion of the West Yellowstone Entrance to Madison roadway, and the West Yellowstone Entrance itself. The town of West Yellowstone was subdivided into two large area sources where the woodstove PM_{10} emissions were allocated based on the total surface areas of the two area sources. In 1994-1995 winter seasons, they were an estimated 500 woodstoves in the town of West Yellowstone with a total emission rate of 2.11E-04 g/sec (NPS, 1995). This emission rate was back/projected in the baseline year and the current and full implementation years of the proposed alternatives based on oversnow visitor numbers in YELL. The roadways were modeled as line sources, which were subdivided into several area sources of 200 m in length and 20 m in width, in which mobile source PM_{10} emissions were apportioned. They were nine such area sources for Highway 20, 12 for Highway 287, and 15 for the West Entrance to Madison Roadway segment. The traveling and idle mobile emission rates were calculated as presented in Section 5.1. Finally, for the existing conditions and the full implementation year of each alternative, the difference in PM_{10} emission rates relative to the baseline year were calculated and used in the increment analysis modeling. The emission rates and the source characteristics are presented in Appendix D.

4.3. PM_{10} PSD Increment Analysis

The EPA model ISCST3 was used to predict the increment consumptions for both the 24-hour and annual averages. The woodstove sources were assigned a height of 7 m. The line sources were assumed to be at ground level. The same five years (1987-1991) worth of winter season (December – March) of hourly surface and upper air meteorological data from the National Weather Service (NWS) stations located in Great Falls International Airport, MT used in Section 4.1 also were used here. The terrain in the impact area was assumed rural, and its elevations assumed to be 500 ft. A 100-m spacing Cartesian receptor grid extending from the west Yellowstone Entrance up to 1000 m in each direction was used in the analysis. Tables 35 and 36 summarize the modeling results.

Table 35. 24-hr Average PM_{10} PSD Increment Consumption

Alternative	24-hr average Maximum PM_{10} Concentrations ($\mu g/m^3$)				
	1987	**1988**	**1989**	**1990**	**1991**
Existing Conditions	3.276	5.693	4.478	2.868	4.436
Alternative 1a/1b	0.002	0.003	0.002	0.002	0.001
Alternative 2	1.545	2.696	2.111	1.364	2.098
Alternative 3	0.005	0.006	0.005	0.004	0.003
Alternative 4	0.005	0.006	0.005	0.004	0.003

Table 36. Annual Average PM_{10} PSD Increment Consumption

Alternative	Annual Average Maximum PM_{10} Concentrations ($\mu g/m^3$)				
	1987	**1988**	**1989**	**1990**	**1991**
Existing Conditions	1.375	1.296	1.351	1.227	1.263
Alternative 1a/1b	0.000	0.000	0.000	0.000	0.000
Alternative 2	0.648	0.611	0.637	0.578	0.595
Alternative 3	0.0002	0.0003	0.0000	0.0004	0.0004
Alternative 4	0.0002	0.0003	0.0000	0.0004	0.0004

For both the 24-hour and annual averaging periods, the predicted maximum PM_{10} concentrations are less than the Class I PM_{10} increments of 8.0 and 4.0 µg/m^3, respectively. In both cases, Alternatives 1a and 1b show the lowest increment consumptions, followed by Alternatives 3 and 4, and Alternative 2. The existing conditions show the highest increment consumptions.

5. TOTAL MOBILE EMISSIONS

In addition to the air quality and PM_{10} increment analyses, the total winter-season mobile emissions of criteria pollutants (CO, PM_{10}, NO_X, and HC) and selected toxic air pollutants (benzene, 1,3-butadiene, formaldehyde, and acetaldehyde) inside the park units were estimated for the implementation years of each alternative. The estimations were based on the winter use scenarios presented in Appendix B and the emission factors presented in Section 3.

5.1. Criteria Pollutants

The following formulations were used to estimate the mass emission rates of criteria pollutant. For the traveling mass emissions,

$$E_T = EF_T \; x \; D \; x \; N \; x \; 90 \, / \, 453.6 \, / \, 2000$$

For the idle mass emissions,

$$E_I = EF_I \; x \; T_I \; x \; N \; x \; 90 \, / \, 453.6 \, / \, 2000$$

Where E_T, E_I = traveling and idle emission rate (tons/year)

EF_T, EF_I = traveling emission factor (g/veh-mile) and idle emission factor (g/veh-hr)

D = round trip distance (mile)

N = number of vehicles (vehicle/day)

90 = number of days in a winter year

453.6 = conversion factor from g to lb

2000 = conversion factor from lb to ton.

In addition to visitor snowmobiles, the NPS and its principal concessionaire currently operate approximately 200 snowmobiles, and estimates of emissions from these machines also are included in the parks' emission totals, which are presented in Table 37 by alternative. The breakdown of emissions per alternative, location, and vehicle type is presented in Appendix E.

Table 37. Winter Use Total Mobile Emissions inside the Parks

Alternative	CO (tpy)	PM_{10} (tpy)	HC (tpy)	NO_X (tpy)
Existing Conditions (2001-2002)	1,925	10.0	674	16
Alt 1a Year 2 (2003-2004) and beyond	313	1.1	44	11
Alt 1b Year 3 (2004-2005) and beyond	313	1.1	44	11
Alt 2 Year 3 (2004-2005) and beyond	1,297	10.4	444	13
Alt 3 Year 2 (2003-3004) and beyond	669	1.2	69	66
Alt 4 Year 2 (2003-3004) and beyond	621	1.1	67	62

5.2. Toxic Air Pollutants

Toxic air pollutants, also known as hazardous air pollutants, are those pollutants that are known or suspected to cause cancer or other serious health effects, such as reproductive or birth defects or adverse environmental effects. Most air toxics originate from human-made sources, including mobile sources (e.g., cars, trucks, buses) and stationary sources (e.g., factories, refineries, power plants), as well as indoor sources (e.g., some building materials and cleaning solvents). Some air toxics are also released from natural sources such as volcanic eruptions and forest fires.

Toxic air pollutants that are formed by the evaporation and incomplete combustion of gasoline include benzene, 1,3-butadiene, formaldehyde, and acetaldehyde. Exposure to air toxics contained in automobile and snowmobile exhaust can result in respiratory and neurological effects. In addition, several of these air toxics have been shown to be carcinogenic.

Although no estimates of air toxics impacts were generated during this study, previous studies have documented personal exposure to some air toxics in Yellowstone NP. During the winter of 1999, personal exposure measurements of park employees were conducted by the University of California at Davis. The fixed monitoring sites showed the same types of gasoline-associated toxic compounds (e.g., benzene) at each location, but concentrations were highest at the West Entrance. Park employees at this West Yellowstone entrance had the greatest exposure, followed by snowmobile patrol rangers, followed by a snowmobile mechanic. The study showed that the concentration of benzene for some employees could approach the Recommended Exposure Levels as established by the National Institute for Occupational Safety and Health (Kado 1999, NPS 2000a).

Toxic air emissions have been measured as a fraction of mass hydrocarbons from 2-stroke and 4-stroke nonroad engines. Specifically, the EPA has summarized several air toxic species as a percentage of total hydrocarbons generated from 2-stroke and 4-stroke nonroad engines (EPA 1996). There are separate emission factors for 2-stroke and 4-stroke engines. The 2-stroke emission factor was used for the existing conditions, and an average of the 2-stroke and 4-stroke emission factors was used for the full implementation years of all alternatives. Using the total hydrocarbons presented in Table 37, total emissions for the four compounds of interested that are generated by mobile sources operating in the parks during the winter season were estimated and are summarized in Table 38.

Table 38. Winter Use Mobile Toxic Air Emissions inside the Parks

Alternative	Benzene (tpy)	1,3 Butadiene (tpy)	Formaldehyde (tpy)	Acetaldehyde (tpy)
Existing Conditions (2001-2002)	8.09	1.08	2.43	0.54
Alt 1a Year 2 (2003-2004) and beyond	0.53	0.07	0.16	0.04
Alt 1b Year 3 (2004-2005) and beyond	0.53	0.07	0.16	0.04
Alt 2 Year 3 (2004-2005) and beyond	5.33	0.71	1.60	0.36
Alt 3 Year 2 (2003-3004) and beyond	0.83	0.11	0.25	0.06
Alt 4 Year 2 (2003-3004) and beyond	0.80	0.11	0.24	0.05

6. VISIBILITY MODELING

A visibility assessment was conducted following the procedures outlined in the *Workbook for Plume Visual Impact Screening and Analysis* (EPA 1992). These procedures are designed to analyze the visibility impacts of plumes from industrial stacks. The winter use visibility analysis required the assessment of line and area source emissions, and the analysis techniques were adapted to meet this requirement using virtual point source methods.

6.1 Visibility Impacts

Visibility impacts were assessed by whether the air emissions from an alternative are likely to cause a visibility impairment that would be perceptible to an observer. Screening values described in the *Workbook for Plume Visual Impact Screening and Analysis* (EPA 1992) are used. A summary of the perception of visibility impairment associated with each alternative and winter use year is provided in Table 39.

Existing Conditions

The visibility assessment indicates that under existing conditions, vehicular emissions would cause localized, perceptible, visibility impairment near the West Entrance, along the West Entrance to Madison Roadway, and in the areas around Old Faithful and Flagg Ranch. However, vehicular emissions would not cause localized, perceptible visibility impairment along the other heavily used roadway segments.

Alternatives 1a and 1b

The visibility assessment indicates that under these alternatives for the full implementation year, vehicular emissions would not cause localized, perceptible, visibility impairment near the West Entrance, in the areas around Old Faithful and Flagg Ranch, or along the heavily used roadway segments.

Table 39. Visibility Impairment

Alternative	Visibility Impairment Perceptible						
	West Entrance	West Entrance - Madison Roadway	Old Faithful Staging Area	Flagg Ranch Staging Area	Flagg Ranch - Coulter Bay CDST	Flagg Ranch - Coulter Bay Roadway	Mammoth-Northeast Entrance Raodway
Existing Conditions (2001-2002)	Yes	Yes	Yes	Yes	No	No	No
Alt 1a Year 1 (2002-2003)	Yes	Yes	Yes	Yes	No	No	No
Alt 1a Year 2 (2003-2004) and beyond	No	No	No	No	No	No	No
Alt 1b Year 1 (2002-2003)	Yes	Yes	Yes	Yes	No	No	No
Alt 1b Year 2 (2003-3004)	Yes	Yes	Yes	Yes	No	No	No
Alt 1b Year 3 (2004-2005) and beyond	No	No	No	No	No	No	No
Alt 2 Year 1 (2002-2003)	Yes	Yes	Yes	Yes	No	No	No
Alt 2 Year 2 (2003-3004)	Yes	Yes	Yes	Yes	No	No	No
Alt 2 Year 3 (2004-2005) and beyond	Yes	Yes	Yes	Yes	No	No	No
Alt 3 Year 1 (2002-2003)	Yes	Yes	Yes	Yes	No	No	No
Alt 3 Year 2 (2003-3004) and beyond	No	No	Yes	Yes	No	No	No
Alt 4 Year 1 (2002-2003)	Yes	Yes	Yes	Yes	No	No	No
Alt 4 Year 2 (2003-3004) and beyond	No	No	Yes	No	No	No	No

Alternative 2

The visibility assessment indicates that under this alternative for the full implementation year, vehicular emissions would cause localized, perceptible, visibility impairment near the West Entrance, along the West Entrance to Madison Roadway, and in the areas around Old Faithful and Flagg Ranch. However, vehicular emissions would not cause localized, perceptible visibility impairment along the other heavily used roadway segments.

Alternative 3

The visibility assessment indicates that under this alternative for the full implementation year, vehicular emissions would cause localized, perceptible, visibility impairment in the areas around Old Faithful and Flagg Ranch. However, vehicular emissions would not cause localized, perceptible visibility impairment near the West Entrance and along the heavily used roadway segments.

Alternative 4

The visibility assessment indicates that under this alternative for the full implementation year, vehicular emissions would cause localized, perceptible, visibility impairment in the areas around Old Faithful. However, vehicular emissions would not cause localized, perceptible visibility impairment near the West Entrance, in the area around Flagg Ranch, or along the heavily used roadway segments.

7. CONCLUSIONS

In support of the Winter Use Plans/SEIS for Yellowstone and Grand Teton National Parks and the John D. Rockefeller, Jr., Memorial Parkway, several air quality analyses were performed. The air quality impacts of CO and PM_{10} were assessed for all the alternatives. The PM_{10} PSD increment consumptions were estimated for the implementation years of each alternative. The total winter-season mobile emissions of CO, PM_{10}, NO_X, HC, benzene, 1,3-butadiene, formaldehyde, and acetaldehyde inside the park units were calculated for the implementation years of each alternative. Finally, a perception of visibility was determined for all the alternatives.

The results of the air quality analysis revealed that none of the predicted maximum CO and PM_{10} concentrations exceed the Montana, Wyoming or National AAQS. Moreover, Alternative 1a and 1b showed a much higher decrease in pollutant concentration relative to the existing conditions. Alternative 2 was the worst alternative in that regard.

The results of the PM_{10} PSD increment analysis showed that, for the full implementation year of each alternative, the Class I PM_{10} 24-hr and annual average increments were not threatened.

For the full implementation years, CO emissions varied from 312 tpy (Alt 1a and 1b) to 1,925 tpy (Existing Conditions; PM_{10} emissions from 1.1 tpy (Alt 1a and 1b) to 10.4 (Alt 2) tpy; NO_X emissions from 11 tpy (Alt 1a and 1b) to 66 tpy (Alt 3); and HC emissions varied from 44 tpy (Alt 1a and 1b) to 674 tpy (Existing Conditions). The lowest emissions occurred in Alternatives 1a and 1b. Since the air toxics emissions were calculated as a direct function of total HC emissions, they followed the same pattern as those for HC emissions for each alternative.

The visibility assessment indicates that under existing conditions and Alternative 2 for the full implementation year, vehicular emissions would cause localized, perceptible, visibility impairment near the West Entrance, along the West Entrance to Madison Roadway, and in the areas around Old Faithful and Flagg Ranch. However, vehicular emissions would not cause localized, perceptible visibility impairment along the other heavily used roadway segments. For Alternatives 1a and 1b for the full implementation year, vehicular emissions would not cause localized, perceptible, visibility impairment near the West Entrance, in the areas around Old Faithful and Flagg Ranch, or along the heavily used roadway segments.

For Alternative 3 for the full implementation year, vehicular emissions would cause localized, perceptible, visibility impairment in the areas around Old Faithful and Flagg Ranch. However, vehicular emissions would not cause localized, perceptible visibility impairment near the West Entrance and along the heavily used roadway segments. Finally, for Alternative 4 for the full implementation year, vehicular emissions would cause localized, perceptible, visibility impairment in the areas around Old Faithful. However, vehicular emissions would not cause localized, perceptible visibility impairment near the West Entrance, in the area around Flagg Ranch, or along the heavily used roadway segments.

8. REFERENCES

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APPENDIX A

EMISSION FACTOR DEVELOPMENT

Microsoft Word
Document

APPENDIX B

WINTER MOTORIZED USE SCENARIOS

Microsoft Word
Document

APPENDIX C

AIR QUALITY MODELING DATA

SEISDataN2.xls

APPENDIX D

PM10 PSD INCREMENT ANALYSIS DATA

(See object in Appendix C)

APPENDIX E

TOTAL MOBILE EMISSIONS

(See object in Appendix C)

APPENDIX F

VISIBILITY MODELING DATA

(See object in Appendix C)